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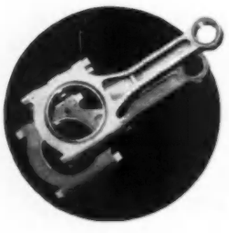

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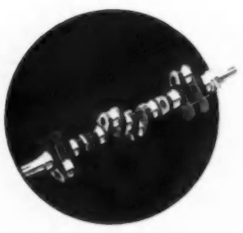

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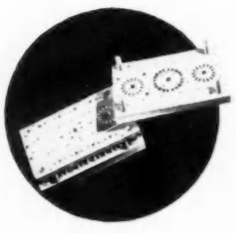

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WELDED TRUSSED PURLINS.

By FELIX J. SAMUELY.

To derive the maximum economy from the welding of structural steel, it is necessary to avoid the mistake of imitating the more familiar riveted constructions. If there is a choice between various types of member for a particular purpose it will often result in entirely different selection if welded, instead of riveted, construction is used. This makes it necessary to adopt appropriate principles of design from the start. An interesting example is the planning of wide span roofs for workshops, theatres, exhibition halls, etc. Typical riveted construction consists, in general, of roof trusses and purlins, the latter being made from simple rolled sections. For long spans these purlins would become very heavy and the distance between the trusses is usually kept within restricted limits, even if the span of the trusses is considerable and a multiple of the distance between them. The plan usually adopted is shown in Fig. 1(*a*), on this page. Only in exceptional cases is it found economical to replace simple rolled sections by trussed purlins, as the number of cleats and the amount of labour required for small riveted trusses is so great that it is more advantageous to use a greater number of trusses arranged closer together.

Light welded trusses do not suffer from this disadvantage and, by suitable selection of shape and section, they can be constructed almost without cleats and with a minimum of labour. As a result, trussed purlins of long span can be adopted, so that a system with a reduced number of main trusses may be employed. This results both in economy of material and ease of erection, and a plan of a welded construction in which advantage is taken of this possibility is shown in Fig. 1(*b*). As an alternative, a combination of long and short span members can be used, as shown in Fig. 1(*c*). Here the number of main trusses, *a*, is reduced to a minimum, but secondary trusses, *c*, are provided; they are carried by the main purlins, *b*. Secondary purlins, *d*, of short span, are employed between all trusses.

Simple welded trusses can compete with joists and other rolled sections even for such short spans as 12 ft. to 15 ft. This is mainly due to the fact that round and flat bars can be used in addition to rolled sections, there being no need to provide rivet holes. Fig. 2 shows the simplest form of trussed purlin, that of a triangle. The lower chord, which acts in tension, consists of a flat section with the wider dimension normal to the plane of the truss. This flat is merely bent about its weaker axis at the lowest point A and connected to the upper chord at both ends, B and C, by means of fillet welds. Owing to its position, it is stiff enough to escape damage during transport to the site. The upper chord, which has to transmit compression and often bending, can be made up of two small channels or unequal angles. The vertical member in the centre may consist of a tube, a joist, a channel or two angles toe to toe, depending on the span of the purlin. Usually the tubular section is the most economical, particularly as thin walls can be used with less danger of corrosion than there would be with flanges of the same thickness.

There is no difficulty in determining the stresses. The upper chord acts as a beam, supported at both ends of the truss and by the centre vertical. Owing to the slight deflection in the centre, the negative bending moment is somewhat smaller than in an ordinary beam on three supports and a value of $M = \pm \frac{w l^2}{40}$ can be taken for positive as well as negative bending moments. An example of this, is a purlin with an equally distributed load of $w = 1{,}600$ lb. per foot run and a total span of $l = 15$ ft., with an upper chord comprising two channels and a lower chord consisting of a flat. The total weight of such a truss would be 230 lb. A rolled-steel joist would require a section modulus $Z = 30$ in.^{3}, so that a joist 12 in. by 5 in. would be selected. This would weigh 450 lb., showing the saving in weight effected by using the welded truss to be 48·5 per cent. A similar member, with a sloping upper chord, is shown in Fig. 3. It was used for one of the short trusses *c* in Fig. 1 (*c*). In this case there is no distributed load but only a vertical load in the centre, due to the load of the purlin, so that the upper chord is not subjected to bending moments. With long span trusses, the triangular shape can be further developed, but this should not be done by adding triangle to triangle, as when building up a riveted lattice girder. By utilising the stiffness of the upper chord, instead of introducing diagonals, a much simpler type is established requiring only a fraction of the labour usually spent on lattice girders. The principle of such a "half lattice" girder is illustrated by Fig. 4 (*a*) (*b*) (*c*). The upper chord invariably has to resist bending moments, but these can be reduced to a minimum by care in designing the lower chord, at least where the span is long enough to justify a large number of verticals. Of the three forms shown in Fig. 4, the last one, (*c*), is statically the best. The calculation of these trussed purlins is dealt with below. For the design it is necessary to remember that such "half lattice" girders (the application of which is by no means limited to purlins) are most economical if the live, that is the variable, load is small compared with the constant load. This type, therefore, would not be particularly suitable for crane girders.

As will be understood from the following calculations, the best shape for the lower chord is one which forms a link polygon for the dead load plus half the live load, which is assumed to be concentrated at the points D_1, D_2, etc., in Fig. 4 (*c*). In detail, the trusses are similar to the triangular girder already set out. The lower chord would best be made up of a plate bent at the connections to every vertical, A_1, A_2, etc., in Fig. 4 (*c*) and welded to the upper chord at each end, B and C, as already described. The upper chord could again be constructed from two channels back to back with sufficient space between them to insert the flat at B and C. The verticals would also fit in between the two channels and would connect them to each other, or alternatively, butt against specially arranged batten plates. Such a construction is shown in Fig. 5, page 282, several types of verticals being indicated, although in practice, naturally, only one type would be used in each girder. If tubular

Fig. 1.

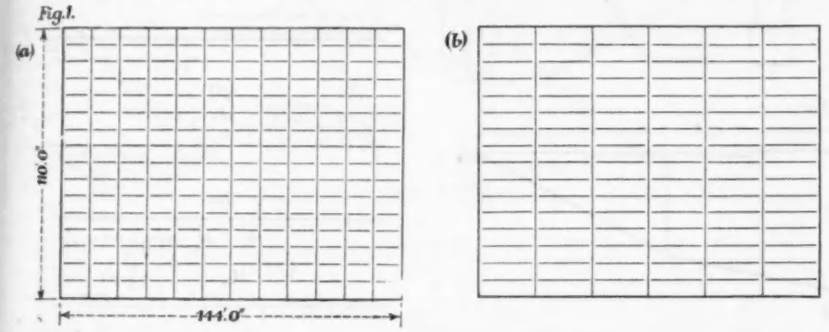


Fig. 2.

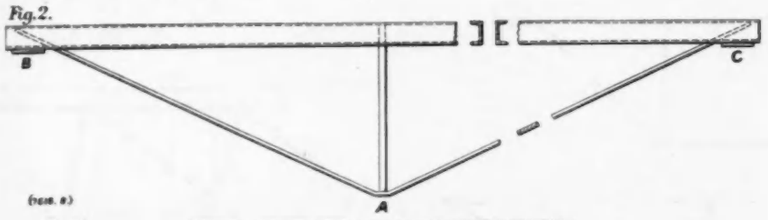


Fig. 3.

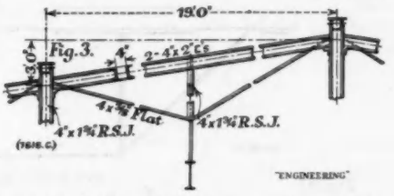
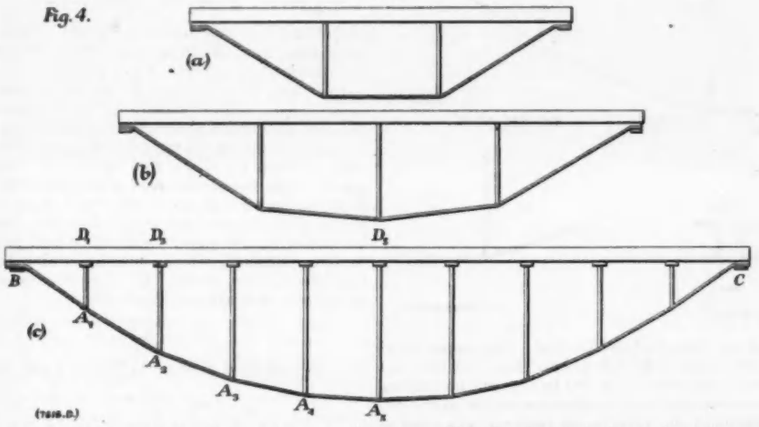


Fig. 4.



WELDED TRUSSED PURLINS.

Fig. 5.

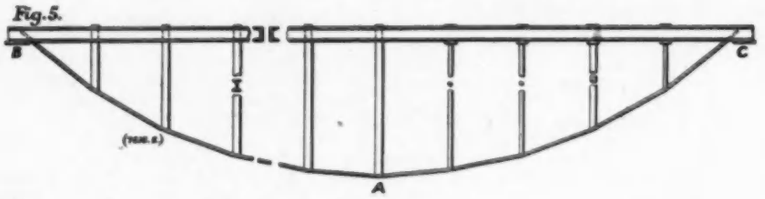


Fig. 6.

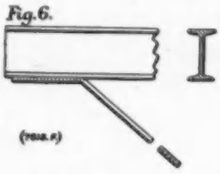


Fig. 7. (a) (b)

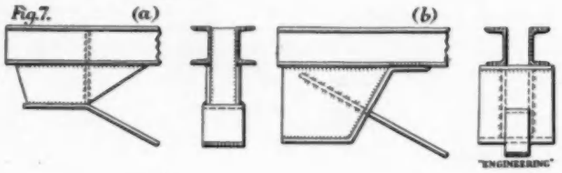


Fig. 9. (a)

(b)

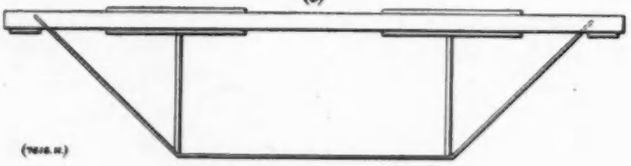
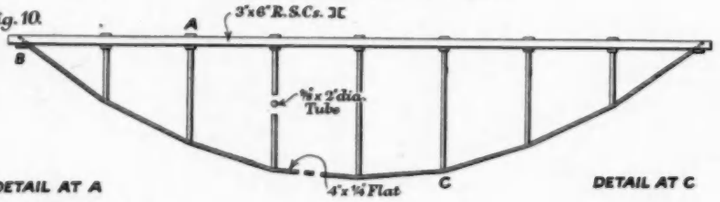
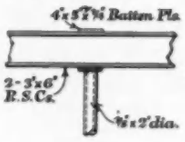


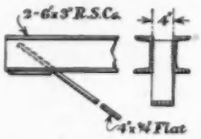
Fig. 10.



DETAIL AT A



DETAIL AT B



DETAIL AT C

Fig. 8.

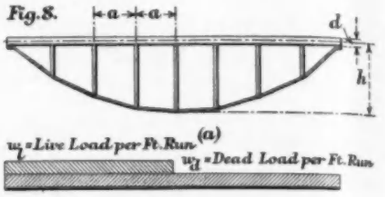
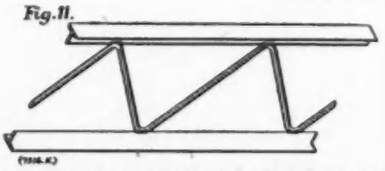


Fig. 11.



verticals are used, and these are generally the most suitable, the open ends must be closed to prevent moisture reaching the interior. As an alternative, the upper chord can be made from an R.S.J. and in this case it is sufficient if the flat which forms the lower chord is bent at the ends and connected to the lower flange as shown in Fig. 6. The weight of long and heavily loaded trusses can be further decreased if a certain eccentricity of connection is provided, giving a negative bending moment at the support but reducing the maximum bending moment. Methods of making such a connection are shown in Fig. 7 (*a*) and (*b*). An R.S.J. is suitable only if the purlin is stiffened sideways at several points; for example, by secondary trusses, so that the sideways buckling length is greatly reduced.

The calculation of stresses in girders of this type, which are statically indeterminate, can be done by the principle of least work, but they lend themselves to a simple approximation, as follows: If the total depth is a multiple of the depth of the upper chord (say, at least 10 times), it can be assumed that the lower chord acts as a chain carrying the load. If properly designed, the link polygon of the chord conforms to the shape of a chain carrying the dead load plus half the live load. The upper chord merely holds both ends of this chain together and acts in compression. It has to transmit no bending moments, apart from local moments due to the distribution of the loads to the verticals, which act as supports and transmit the load to the lower chord. These local moments, however, can often be neglected. If the total depth is less than ten times the depth of the upper chord, the stresses in this chord due to the deflection of a truss cannot safely be neglected and a correction moment has to be made. This is dealt with below.

Any loading varying from that for which the shape of the lower chord has been designed may not be taken entirely by this chord and produces bending moments in the upper chord. These will be the greater the more one-sided such live load is, and the greatest bending stresses would be produced by dead load on one half and dead load plus superimposed load on the other half of the truss, as indicated in Fig. 8(*a*). In the most frequent case of symmetrical girders, such loading can be conveniently considered as the sum of two loadings: (1) Dead load plus half the live load acting over the whole length, as indicated in Fig. 8 (*b*), and (2) half the live load acting downward on one half of the truss and half the live load acting upwards on the other half, as shown in Fig. 8 (*c*).

This division of loading can be carried out for single loads as well as for uniformly distributed loads. The first part would be symmetrical and produce no bending moment in the upper chord, being identical with the load for which the lower chord was designed, while the second part is asymmetrical and produces no force at all in the lower chord. The whole of this second part would, therefore, have to be carried by the upper chord alone and produce bending moments, which, however, owing to the load distribution, would be comparatively small. In the case of equally distributed load

$$M = \frac{w_l \times l^2}{32} \quad . \quad . \quad . \quad (1)$$

and the horizontal force in the chords would be

$$H = \frac{\left(w_d + \frac{w_l}{2}\right) l^2}{8h} \quad . \quad . \quad . \quad (2)$$

where

l = total length,
h = distance between centre lines of the chords in the middle,
w_l = live load per ft. run, and
w_d = dead load per ft. run.

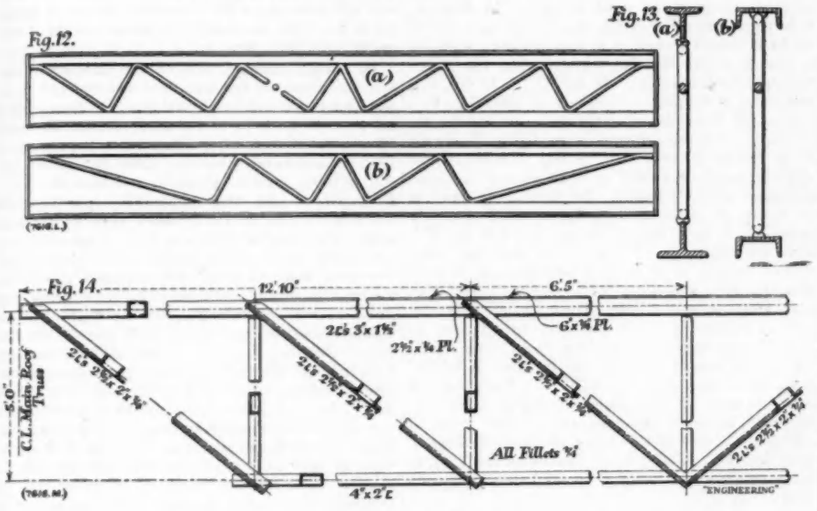
The shape of the bending moment diagram for a uniformly distributed load would be as shown in Fig. 8 (*d*).

In Fig. 8(*e*) the shape of a correction bending moment diagram is shown in a case where $\frac{h}{d}$ is smaller than 10. In this case the upper chord carries a portion α of dead plus half live load, where

$$\alpha = \frac{1}{5\frac{h^2}{d^2} + 1} \quad . \quad . \quad . \quad . \quad (3)$$

Only positive bending moments are produced, the

WELDED TRUSSED PURLINS.



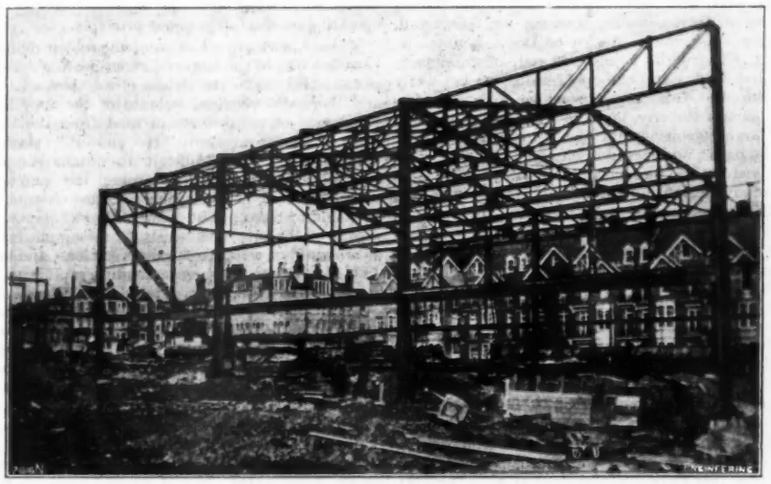


FIG. 15.

maximum being in the centre. Fig. 8 (*e*) illustrates the case of equally distributed load where

$$M_{c_1} = \alpha \left(w_d + \frac{w_l}{2} \right) \frac{l^2}{8} \quad . \quad . \quad (4)$$

Another correction may have to be made for local bending moments which are indicated in Fig. 8 (*f*). Approximate methods will always be sufficient for these as they are invariably smaller than the bending moments due to eccentric loading. The negative and positive bending moments, respectively, are

$$M_{c_2} = -(w_d + w_l)\frac{a^2}{12} \quad . \quad . \quad (5a)$$

$$M_{c_3} = +(w_d + w_l)\frac{a^2}{24} \quad . \quad . \quad (5b)$$

where a = the panel length. These corrections can be neglected when $\frac{a}{l}$ is equal to or less than $\frac{1}{8}$. In cases where large bending moments are to be transmitted, it is important to remember that, in accordance with Fig. 8 (*d*), these moments do not occur all over but are centred in the neighbourhood of the quarter points. It is quite feasible to have smaller sections for the upper chord, with flange plates only where the greatest bending moments occur, as shown in Fig. 9 (*a*) and (*b*), opposite.

A practical example of a welded purlin of 40 ft. span carrying a uniformly distributed load of 400 lb. per foot run is illustrated in Fig. 10. Of the total load, 160 lb. per foot run is dead load, the rest being live load. If a shape with eight panels is selected, as shown, with a depth from the centre line of the upper chord to the centre line of the lower chord of 8 ft. in the middle, the greatest force in the lower chord in the centre, with full load, would be, from (2),

$$H = 400 \times \frac{40^2}{8 \times 8} = 10{,}000 \text{ lb.}$$
$$= 4{\cdot}5 \text{ tons.}$$

This force would be increased in the lower chord near the supports owing to the slope and would be $\frac{4{\cdot}5}{\cos B} = 5{\cdot}76$ tons. With a permitted stress of 8 tons per square inch, the required sectional area $A = \frac{5{\cdot}76}{8} = 0{\cdot}72$ sq. in. A plate 4 in. by $\frac{1}{4}$ in. is ample.

The upper chord would have its greatest bending moments at the quarter points with half the truss loaded, and, from (1)

$$M = \frac{240 \times 40^2}{32} = 12{,}000 \text{ lb.-ft.}$$
$$= 64{\cdot}8 \text{ tons-in.}$$

In this case—

$$w_d + \frac{w_l}{2} = 280 \text{ lb. per ft. run, and}$$
$$w_l = 240 \text{ lb. per ft. run.}$$

Assuming $d = 6$ in. and $h = 16$ ft., the correction moments would be (from (4) (5 *a*) and (5 *b*))

$$M_{c_1} = \frac{280 \times 40^2}{(5 \times 16^2 + 1)\,8} = 44 \text{ lb.-ft.}$$

$$M_{c_2} = -\frac{280 \times 4^2}{12} = 372 \text{ lb.-ft.}$$

$$M_{c_3} = +\frac{230 \times 4^2}{24} = 186 \text{ lb.-ft.}$$

M_{c_1} and the positive M_{c_3} may be neglected. The negative $M_{c_2} = -2$ tons-in. The greatest negative moment $-64{\cdot}8 - 2 = -66{\cdot}8$ tons-in.

The normal force acting together with the bending moment is $4{\cdot}5 \times \frac{280}{400} = 3{\cdot}15$ tons, or alternatively, 4·5 tons acting without bending moment, in the case of the girder when fully loaded. Assuming that the truss can be stiffened sideways at the centre point so that the buckling length for the upper chord will be 20 ft. = 240 in., choose two channels 6 in. × 3 in. × 12·4 lb. with 4 in. distance back to back: then

$$A = 2 \times 3{\cdot}65 = 7{\cdot}3 \text{ sq. in.}$$
$$Z = 2 \times 7{\cdot}09 = 14{\cdot}18 \text{ in.}^3$$
$$r_x = 2{\cdot}41 \text{ in.}$$
$$r_y = \sqrt{2{\cdot}89^2 + 0{\cdot}88^2} = 3{\cdot}02 \text{ in.}$$
$$\frac{l}{r} = \frac{240}{3{\cdot}02} = 80.$$

Permissible stress (L.C.C. regulations) for direct stress only is 4·9 tons per square inch. For direct stress and bending, the permissible stress is

$$F_s = \frac{3{\cdot}15}{7{\cdot}3} + 7{\cdot}5\left(1 - \frac{3{\cdot}15}{7{\cdot}3 \times 4{\cdot}9}\right)(1 - 0{\cdot}002 \times 80)$$
$$= 6{\cdot}18 \text{ tons per sq. in.}$$

The actual stress

$$= \frac{3{\cdot}15}{7{\cdot}3} + \frac{64{\cdot}8}{14{\cdot}18} = 0{\cdot}43 + 4{\cdot}57 = 5{\cdot}00 \text{ tons per sq. in.}$$

For the verticals, $V = 4 \times 400 = 1{,}600$ lb. = 0·71 ton, and for the longest vertical in centre $l = 8$ ft. 0 in. = 96 in. Take a tube 2 in. in diameter and × ⅛ in. in thickness: then

$$A = 1{\cdot}47 \text{ sq. in.}$$
$$r = 0{\cdot}76 \text{ in. and}$$
$$\frac{l}{r} = \frac{96}{0{\cdot}76} = 127.$$

The permitted stress = 2·7 tons per square inch and the actual stress $= \frac{0{\cdot}71}{1{\cdot}47} = 0{\cdot}5$ ton per square inch. The total weight of such a truss would be 1,300 lb., approximately 32·5 lb. per foot run, equivalent to an ordinary 12 in. × 5 in. R.S.J.

An entirely different type of purlin is obtained by keeping to the principle of ordinary lattice girders but using a round bar for the filling members, as shown in Fig. 11, opposite. This construction is used mostly in connection with parallel chords and as the bar can be bent cold, just as an ordinary bar in reinforced concrete, very little labour is involved. The diagonals would be alternately stressed in tension and compression. Although, owing to the small radius of gyration the stresses permitted in the compression diagonal are comparatively small, the arrangement will be economical where the depth permitted is not as great as that used by a parabolic purlin. Some alternative arrangements for this type of construction are shown in Figs. 12 (*a*) and (*b*), in which savings are made by shortening the compression diagonal compared with that for tension, and by lengthening the first panels near the support, in which tension is to be taken by the diagonal, in order to reduce the greatest compression in the diagonals which occurs in the second panel. The upper and lower chords can be constructed from T or channel sections, as shown in Fig. 13 (*a*) and (*b*).

Trussed purlins can also be constructed in the usual way as lattice girders, particularly for members *b* in Fig. 1 (*c*). By reasonable arrangement of the sections, the number of cleats for these purlins can be reduced so that they are negligible, and the construction of the truss becomes simple. The upper chord is best made up of two channels or angles, toe to toe, while the lower chord may consist of only one channel. The verticals can rest between the chords transmitting their forces in direct compression, so that the amount of welding is reduced to a minimum. The diagonals, consisting of one angle on each side of the chord, are fixed by fillet welds. Such a truss is shown in Fig. 14, with additional plates for the chords in the centre. Fig. 15 shows an example in which, by the application of these principles, a particularly light and economical structure has been obtained.

DISTRICT HEATING IN THE UNITED STATES AND RUSSIA.

By David Brownlie.

(*Concluded from page* 185.)

One of the most remarkable features of the vast industrial and scientific development of Russia since the revolution is the extensive use of district heating by means of exhaust steam and hot water from central electricity stations of the largest size, specially designed for both purposes. These are known in Russia as combined heat and power or "H. and P." stations, and work on the ideal principle of high steam pressure and superheated-steam temperature, with back-pressure and pass-out steam turbines supplying the whole, or a great part, of the exhaust steam for heating and process work. The object is to operate eventually more or less the whole of the steam-driven power stations of Russia on these lines, and it is understood that, at the outbreak of war with Germany, nearly 2,000,000 kW of these "H. and P." stations were in service. Probably an average thermal efficiency was being obtained of about 50 per cent. to 60 per cent., and even 70 per cent.; though in a considerable proportion of cases, due to insufficiency of local heat demand, it was not possible to use all the exhaust steam.

The construction of "H. and P." stations and the extension of district heating was one of the main features of the second Five-Year Plan (1933 to 1937, inclusive), although it was also prominently included in the first Five-Year Plan. So far as can be ascertained, in 1929 the total plant of these stations, 65 in number, was about 1,500,000 kW, supplying a maximum of 27,500 million B.Th.U. per hour as exhaust steam or hot water obtained by using exhaust steam. This is equal to about 8 million metric tons of coal per annum, or over 16 million tons burnt in ordinary domestic heating equipment such as stoves and hot-water boilers. In 1935, with about 1,000,000 kW of "H. and P." stations in operation, the total length of district-heating mains in Russia was about 124 miles, but by 1939 this had increased to 500 miles.

The extent of these developments, is indicated by the fact that in 1937, at the end of the second Five-Year Plan, the Central regional system of Russia, inclu ing Moscow, Gorki, Ivanovo and Yaraslavl, had 40 per cent. of its power plants working on the "H. and P." system and 60 per cent. on the condensing system. In the Urals regional area, 41 per cent. was "H. and P." and 59 per cent. condensing; while the Southern regional area, including the Donetz basin, the Dnieper, and Azov-Black Sea districts, had 8 per cent. "H. and P.," 70 per cent. condensing steam, and 22 per cent. hydro-electric. These three systems are the most important in Russia and between them generate 75 per cent. of the total electricity output of the whole country, their output in 1937 being 4,100 million kWh. The plan was that, by 1937, 29·8 per cent. of the power stations in Russia would be operating on the "H. and P." system, whereas in 1932 the figure was only 11·9 per cent., although even the latter represents a remarkable achievement. It is difficult to give a concise statistical and technical description of the progress of district heating in Russia up to the outbreak of the present war, because of lack of complete information and also because of the rapidity of its development, especially since 1937.

There are several interesting points in connection with this very extensive experience of district heating in Russia. The first is that, in the case of steam supply, two pressures have now been standardised for general industrial and process steam, namely, 4 atm. to 5 atm. (57 lb. to 70 lb. per square inch) and 12 atm. to 14 atm. (170 lb. to 200 lb. per square inch). Also, for domestic heating, hot water is largely used under pressure, generally at a standard average temperature of 120 deg. C. to 130 deg. C. (248 deg. F. to 266 deg. F.); in which Russia differs from other countries, where steam water-heating is almost universal. It has been found by experience, especially in Moscow, that hot water can be easily distributed over distances from 6 miles to 7½ miles and that the above average standard temperature range is the most suitable. In Moscow, however, as in other cities, the temperature of the water is varied according to the weather; thus, in a typical severe Russian winter, when the atmospheric temperature is — 25 deg. C. (— 13 deg. F.), hot water is supplied at 130 deg. C. (266 deg. F.); and, as the atmospheric temperature rises to 0 deg. C., the hot-water temperature is gradually decreased from 130 to 70 deg. C. (158 deg. F.), the whole system being organised in this respect on most ingenious lines. Usually, the Russian practice is to return all condensate to the stations, generally at 30 deg. C. to 35 deg. C. (86 deg. F. to 95 deg. F.). For the insulation of the steam and hot-water mains, pumice stone is very largely used, in conjunction with kieselguhr (diatomaceous earth) fire-clay, and compressed peat. The mains are generally laid in shallow concrete conduits, buried 4 ft. to 5 ft. in the earth, the concrete being often made with pumice as one of the constituents. A typical test, on a pipe 470 m. (1,542 ft.) long, with a rate of flow of hot water averaging 4 ft. per second, showed a temperature at the inlet of 100 deg. C., and at the outlet of about 40 deg. C. (104 deg. F.). Under these conditions the drop in temperature was 8¼ deg. C. per kilometre (say, 24 deg. F. per mile).

Some of the more prominent towns having extensive district-heating systems are Leningrad, Moscow, Kharkov, Rostov-on-Don, Kuibyshev, Gorki, Kislovodsk, Nijni-Novgorod, Magnitogorsk, and Kuznetsk. In Leningrad, steam and hot water are supplied from power stations to a considerable part of the city, including, in 1934, more than 200 large establishments such as hospitals, hotels, public baths, and factories, as well as houses. This involved the use of over 20 miles of mains, capable of supplying 416 million B.Th.U. per hour. Part of the system seems to be operating on a special modification of the superheated hot-water principle. Water heated by exhaust steam is circulated under pressure conditions at 100 deg. to 115 deg. C. (212 deg. to 239 deg. F.) to individual buildings, which, however, have a closed tank in the roof to which steam is admitted, together with cold water, so that the actual heating water is below 100 deg. C. at atmospheric pressure.

The first "H. and P." station was the small pioneer "Third Leningrad," of 14,700 kW capacity, started up in 1924, and containing two 4,500-kW pass-out sets, one 5,000-kW set, and one 700-kW set, with 600 m. of mains. On the basis of 1937 practice, this station is operating at 43·5 per cent. thermal efficiency, and is consuming 41,200 metric tons of coal per annum. The annual output is 26,700,000 kWh and 402,000 million B.Th.U. (27 per cent.) as low-pressure steam, and its success was one of the reasons for the great development of the principle. A notable early "H. and P." station also is Grozny, in the Northern Caucasus, completed in 1928. This has two pass-out sets, each of 5,000 kW, usually operated under back-pressure conditions, at a pressure of 30 atmospheres (426 lb. per square inch) and 385 deg. C. (725 deg. F.) superheated-steam temperature. The net overall thermal efficiency is stated to be 54·98 per cent., 26·44 per cent. representing the 156-lb. steam supply, 17·5 per cent. the 43-lb. supply, and 10·95 per cent. electrical power.

The first large "H. and P." station, started up in 1931, was that at Berezniki in the north-west Urals area, which supplies power and exhaust steam to a large group of chemical works and other establishments, as well as steam to houses and other domestic buildings. The plant consists of three high-pressure back-pressure sets, each of 12,800 kW, and a house set of 6,400 kW, presumably also back-pressure. Five boilers, made in the United States, were installed, each of 120 metric tons (265,000 lb.) per hour normal evaporation, and operating at 64 atmospheres (910 lb. per square inch) maximum and 450 deg. C. (842 deg. F.) temperature, with unit pulverised-coal firing. Stop-valve conditions at the turbines are normally 57 atmospheres (810 lb. per square inch) and 435 deg. C. (815 deg. F.), with the steam passing out at 17·5 atmospheres to 19·0 atmospheres (250 lb. to 270 lb. per square inch), and 290 deg. to 305 deg. C. (550 deg. to 580 deg. F.). Each of the 12,800-kW sets will take up to 191 tons (421,000 lb.) of steam per hour, while the 6,400-kW house set takes 100 metric tons per hour.

In normal running, two of the 12,800-kW sets and the house set are used, and 482 metric tons of pass-out steam delivered. Of this, 128 tons is used for process work in surrounding chemical works; 52 tons to 55 tons, after reduction to a pressure of 17·5 atmospheres absolute (260 lb. gauge per square inch), goes to de-aerate and heat the boiler feed-water; and the remainder, approximately 300 tons, is used in low-pressure pass-out turbines after reheating to 375 deg. C., apparently by separately fired superheaters. The turbine sets consist of three of 12,800-kW capacity, generating alternating current, and three of 3,300 kW generating direct current, all taking steam at 16 atmospheres absolute (242 lb. per square inch gauge) and 360 deg. C. (680 deg. F.). The 12,800-kW sets consume 4·65 kg. (10·25 lb.) of steam per kilowatt-hour when working as straight condensing sets. Normally, however, they pass up to 9 metric tons (say, 20,000 lb.) of steam an hour at 6·7 atmospheres absolute (109 lb. per square inch gauge) or 12 metric tons an hour at 3·2 atmospheres absolute (60 lb. gauge). The overall thermal efficiency of the Berezniki installation is given at 58·7 per cent., presumably when the low-pressure turbines are operating on the full pass-out principle.

Moscow, with a population of about four millions, possesses one of the largest district-heating systems in the world, and certainly one of the most scientific and thermally efficient, because of the very large proportion of exhaust steam used from the latest type of super-pressure "H. and P." stations. Unfortunately, it is difficult to obtain complete statistical information concerning the numerous inter-connected power stations of Moscow and the surrounding area; but nearly the whole of the centre of the city now seems to be supplied with steam and hot water from power stations, and since 1938 the service has been extending rapidly to the suburbs. In 1933, it was stated that Moscow had over 15 miles of heating mains supplied by power stations of 345,000 kW capacity, largely operating on the condensing principle. Within the next year or two, over 200 miles of heating mains for industrial and domestic service were to have been in operation. The intention was to have ten new "H. and P." stations for the Moscow area, generating a total of 1,426,000 kW, with a district distribution of 675 million kg.-cal. (2,679 million B.Th.U.) per hour as steam or hot water. One of the first power stations in Moscow to supply any considerable amount of heating steam was Krasnaya-Pressnaya, which began to do so in 1929.

A notable plant in this district is that of the Thermo-Technical Research Institute, famous for its large-scale research and development work in many sections of fuel and power, and especially on super-pressure steam and high temperatures of superheat. It is the most important centre in Russia in this field and has a large power plant of 60,000 kW, supplying electricity as well as steam on the "H. and P." system. The installation includes three Loeffler forced-circulation boilers operating at 130 atm. abs. (1,852 lb. per square inch gauge) and 500 deg. C. (932 deg. F.) superheated steam temperature, with a normal evaporation of 130 metric tons (287,000 lb.) per hour and 150 tons (330,000 lb.) overload for long periods. There is a 24,000-kW back-pressure turbo-generator, taking up to 300 tons (660,000 lb.) of steam an hour, at 125 atm. (1,800 lb. per square inch) and 470 deg. C. (878 deg. F.) at the stop valve. This turbine discharges at 27·0 atm. (400 lb.) to a low-pressure plant consisting of two turbo-generators, one of 24,000 kW and the oth r of 12,000 kW. Apparently the latter only is a pass-out set, supplying 100 metric tons of steam an hour at 5 atm. (85 lb. per square inch gauge). In addition, the plant includes Ramzin forced-circulation monotube super-pressure steam generators, also operating at 130 atm. and 500 deg. C., which were invented at this Research Institute, and special designs of inclined grate stoker to burn air-dried peat at a very

high rate, involving pre-drying and pre-heating of the fuel.

The first large "H. and P." station erected in Moscow was the Stalin, a part of which dates from 1935, in the eastern section of the city. Included in the installation are two pulverised-coal fired boilers, each of 160 metric tons to 200 metric tons normal evaporation, and one pass-out turbine of 25,000 kW capacity, discharging an average of 100 metric tons an hour at a pressure of 17 atm. to 28 atm. abs. (256 lb. to 412 lb. per square inch). In 1937, the Stalin station was enlarged to some 300,000 kW by the addition of 25,000 kW to 50,000 kW pass-out sets which supply steam at two different pressures, namely, 1·2 kg. to 2·0 kg. per square centimetre (for heating buildings) and 12 atm. abs. Another "H. and P." station is the "First Moscow," which has a 3,900-kW set and burns 21,000 tons of coal per annum, operating at 57·2 per cent. efficiency, with an annual output of 7,900,000 kWh, and 309,500 million B.Th.U. as heating steam or hot water. Yet another station is the "Proletarian," the first section of which is of 60,000 kW. Two other large stations are the Frunze and the Krasnaya, each of 100,000 kW.

An outstanding development in Russia is that very large industrial plants operate power stations as far as possible on the "H. and P." principle, supplying their own power requirements, along with the whole of the electricity and steam or hot water required for the district heating of an adjoining town. One of the first and the most important of these industrial stations is at the huge Kuznetsk iron and steel works in Siberia, one of the largest in the world, which has a complete new city of its own with 100,000 inhabitants. The power station is equipped with six turbo-alternator sets, two of which, each of 6,000 kW, run condensing because heating requirements are not sufficient to take all the exhaust steam. In addition, there are four pass-out sets, each of 25,000 kW, the steam conditions at the stop valve being 29 atm. pressure and 400 deg. C. superheated-steam temperature. Three of these sets also supply steam for district heating at a pressure of 3 atm., while the fourth discharges steam at 1·2 atm. to 2·0 atm. Each of these 25,000-kW sets also supplies approximately 100 metric tons of steam an hour; that is, the total distribution from the station amounts to 882,000 lb. of steam per hour, for district heating and for the steelworks.

So far as can be made out, two of the 25,000-kW sets supply all their steam for industrial use, while the other two supply the district heating, which, if this is correct, requires about 440,000 lb. of steam per hour. There is also a station at Kuznetsk, with seven pulverised-coal fired boilers, four of which have a duty of 130 metric tons to 150 metric tons of steam an hour and serve the four main 25,000-kW turbines. Two of the other boilers are somewhat larger, 150 metric tons to 160 metric tons an hour, and supply the steam turbine-driven blowers for the blast-furnace plant and two auxiliary turbo-alternator sets; while the remaining boiler, still larger (160 metric tons to 200 metric tons an hour, is a standby unit.

Even more impressive is the "H. and P." station of the Magnitogorsk iron and steel works in the South Urals, also one of the largest in the world. This is believed to have a capacity of 250,000 kW, and is in two sections; one of 100,000 kW, completed in 1933, and one of 150,000 kW, added later, which supplies steam to the steelworks and (using pass-out turbines) hot water to the large new model town that has been built. Magnitogorsk also has a separate 12,000-kW boiler and power plant for the blast-furnace blowers, which are operated with pass-out turbines and supply all the process steam required by the by-product coke-oven plant. The vast Dnieper metallurgical group of establishments, using hydro-electric plant of about 3,000,000 kW for the manufacture of alloy steels, aluminium, magnesium, and other metals, also supplied a new town with steam and hot water. For this purpose, however, the waste heat from metallurgical furnaces and the water from the cooling of open-hearth electric furnaces was mainly used, constituting a new development in district heating. Presumably, the whole of this plant is now out of action.

LITERATURE.

Mastering Momentum. By DR. L. K. SILLCOX. New York: Simmons-Broadman Publishing Corporation. [Price 2.50 dols.]

THE trends of railway passenger transport, first towards long trains of heavy vehicles, and latterly towards steadily increasing sustained speeds with light-weight construction, have been more pronounced in the United States of America than elsewhere, and the achievement of satisfactory brake control figures prominently among the problems raised by these modern developments. Dr. Sillcox is especially qualified to deal with this subject, being vice-president of the New York Air Brake Company, and having many years of experience in the design and performance of train braking equipment. His book, however, is by no means chiefly concerned with the structural details of brake gears. The substance of the text is adapted from a series of papers presented to the Massachusetts Institute of Technology, and a statement of the fundamental dynamics of train retardation comprises the foundation upon which the author constructs the solutions of individual problems; thus, it is serviceable alike to elementary and advanced students of mechanical train control.

The first, and most extensive, section of the book is devoted to the mechanics of train operation and introduces the ideas of the creation and absorption of kinetic energy, surveying critically the work of Galton and subsequent investigators relative to the practical factors and numerical coefficients which bear upon the performance of brakes in service. In this context the frictional and other physical characteristics of brake materials are discussed, the author's favourable view of non-metallic composition brake blocks, regarding the circumstance that they enable an almost unlimited variety of frictional properties to be produced synthetically, being of particular interest. In the consideration of passenger-car brake equipment, which follows, attention is concentrated upon the air-pressure type of gear, generally used in America, to the exclusion of the automatic vacuum principle more favoured in this country. The mechanical details, therefore, are largely outside the scope of British practice, but the author's comments on those factors which affect the time-response and amount of braking forces, relative to the type, size and working pressure of the equipment, are instructive and serve as a basis for numerical comparisons between calculated and full-scale trial results of brake performance. Attention is paid throughout to the imperfections of many forms and principles of passenger-car braking, in which connection the functions of devices for controlling retardation, detecting wheel slide and improving adhesion are briefly described.

In contrast with this treatise on what may be termed the active control of train retardation, the remainder of the book is concerned with matters which arise incidentally to brake operation, but which, nevertheless, are of great importance to successful passenger-train design and maintenance. The author deals in turn with the mechanics and metallurgy of wheels and axles, and enlarges on the types and causes of service failures in these components associated with severe braking conditions. From a similar standpoint the design of braked trucks on locomotives and coaches is discussed, special attention being directed to the interaction between stability, springing and suspension on the one hand, and the mode and magnitude of brake application on the other. Novel ideas and principles affecting riding are surveyed in relation to braking problems, while the American automatic-coupling type of buffing and drawgear is studied in the detail it deserves, in view of its immediate effect on the absorption and distribution of energy in a train.

The effects of brakes in causing damage to rails, and the structural design of passenger cars to absorb impact energy in collisions, are among the more important aspects implied by the title of the book, but not included in its contents. Experienced railway engineers will discover, moreover, that in certain other directions, the author's treatment is less complete or less strictly to the point than is either desirable or justified. Especially in the second half of the book, where the subject matter is perhaps somewhat outside his specialised knowledge, Dr. Sillcox writes less constructively and authoritatively than he does of strictly braking problems. Even then, however, his review of modern developments never fails to stimulate the reader's imagination and to emphasise the often unsuspected range of train design features upon which braking action exerts an influence.

Practical Construction of Warships. By R. N. NEWTON, R.C.N.C. London: Longmans, Green and Company, Limited. [Price 21*s.* net.]

THE literature of warship building has never been extensive; and since the building of any kind of fighting ship became a task which only a few specialist establishments could undertake, and their detail design a matter of increasing secrecy, both the opportunity and the inducement to write books on the subject have diminished appreciably. Comparatively few have been produced in the past 30 years, in any language, and of those that have appeared, most have been concerned with design rather than construction. An exception was *Shipyard Practice as Applied to Warship Construction*, by N. J. McDermaid, published exactly 30 years ago; but there have been many changes in both design and constructional practice since then, and the time is fully ripe for the appearance of a more modern treatise. This has now been provided by Mr. R. N. Newton, who, like Mr. McDermaid, has based it upon the material of his lectures to dockyard students. Except for the war, no doubt it would have appeared sooner (the preface is dated 1939, although publication did not take place until August, 1941); but the delay is understandable, and the book no less welcome on that account.

Although the general style of the treatment is often reminiscent of the earlier book, as is practically inevitable since both deal with the same subject and are addressed to similar classes of readers, there are several obvious differences; notably, in the attention that Mr. Newton gives to welding and its influence upon design, and to the use of light materials and forms of construction—a development which has assumed importance as a result of the limitations imposed by the Washington Treaty. He makes less use than did Mr. McDermaid of isometric views of details and of such features as the assembly of launching cradles, relying upon line drawings which appear, in many cases, to be reproduced directly from actual drawings. In some of these, the scale of reduction makes the descriptive notes and lettering rather inconveniently small; but in general the illustrations are commendably clear and practical. Considerable space is devoted to the provision to be made for docking and overhaul work; and to equipment such as boats and boat-handling arrangements, anchors and their gear, mess-deck fittings, and masts and spars. War conditions are presumably responsible for the comparatively small use that is made of photographic illustrations, and for the absence of direct references to individual ships or classes other than the general categories of "battleship," "cruiser," and "destroyer." The text is straightforward and concise, no words being wasted. It is introduced by some general notes on design considerations and a section on materials and their uses, testing and treatment. The book should prove eminently serviceable to the staffs of the many private shipyards now engaged on Admiralty work as well as to those in the Royal Dockyards, to whom it is primarily addressed.

THE AIRGRAPH LETTER SERVICE.—Since the institution of the Airgraph letter service a short time ago, one-and-a-quarter million Airgraph letters have been received from, and upwards of half-a-million have been sent to, the Middle East, through the Army Post Office.

THE INSTITUTION OF STRUCTURAL ENGINEERS.—The July examinations of the Institution of Structural Engineers were held in London, Birmingham, Bristol, Edinburgh, Glasgow, Manchester, Middlesbrough, Norwich and Stafford. The total number of candidates appearing at these centres was 91, of whom 32 took the graduateship and 59 the associate-membership examination. Twenty candidates passed the graduateship examination and 42 the associate-membership examination.

OIL-FIRED PORTABLE BOILER.

The supply of small quantities of steam at widely-separated points in a large factory is, theoretically, a simple matter, as the steam may be supplied through pipes from the main boiler plant. Practically, however, condensation gives rise to difficulties particularly where the supply is required only intermittently. Such conditions of distributed demand and intermittent use are common in some factories to-day; for example, those engaged in certain branches of munitions manufacture. Messrs. Merryweather and Sons, Limited, Greenwich High-road, London, S.E.10, have accordingly developed a small boiler which is fired by oil and is easily portable, this boiler being illustrated in Figs. 1 to 3 on this page. The boiler, it may be recognised, is a modification of the form employed by the firm for many years in steam fire engines and manufactured in quantity during the last war for other types of fire-extinguishing equipment.

The boiler is of steel electrically-welded throughout and consists of an upper shell and a firebox bolted together. When at work it stands upon three welded feet as shown; for transport one of three methods can be used. The first of these methods is the mounting of the boiler on the two-wheeled chassis seen in Fig. 1, the connection to the chassis being effected by a pair of forks embracing pins on the shell. These pins are situated above the centre of gravity of the whole assembly so that the boiler remains in the vertical position during transport, and is thus ready for work at its destination. The wheels and handle may, however, be found cumbersome in some circumstances, and are dispensed with in the second method of tramsport. This consists of passing carrying poles, one on each side, through the eyes seen above the pivots and bracketed out from the shell. The boiler can thus be carried in a vertical position by four men and set down where required. The third method is illustrated in Figs. 2 and 3. For this two wheels are bolted to the boiler in the positions shown, so that the assembly may be rolled from place to place. This, in some cases, is a convenient method of transportation, but involves the turning-over and up-ending of the boiler on leaving and reaching a site respectively. The assembly has a net weight of approximately 500 lb. when empty and of 530 lb. when containing water up to the working level.

The boiler is of the tubular type with a central water-walled combustion chamber, through which pass steel water tubes disposed nearly horizontally, and has a central uptake. A steam-actuated oil-fuel burner is fitted in the firebox, the fuel oil being fed by gravity from a closed tank attached to the upper part of the shell. Steam is raised initially by means of a separate auxiliary burner which takes about 5 minutes to start and thereafter will raise steam to a pressure sufficient to atomise the oil in the main burner in about 12 minutes. This burner then functions normally. Steam is thus raised to the working pressure of 100 lb. per square inch from cold in approximately 20 minutes from the time of lighting up the auxiliary burner. Any class of fuel oil, such as kerosene or Diesel oil can be used provided, of course, that its viscosity will permit it to flow from the tank to the burner.

The evaporative capacity of the boiler is 380 lb. of steam per hour at a pressure of 100 lb. per square inch, this giving a rating of 12·25 lb. per hour per square foot of heating surface. The boiler mountings comprise a feed-water injector with a flexible hose suction pipe and delivering through a combined non-return valve and shut-off cock; safety valve; stop valve; steam-jet cock for funnel draught; pressure gauges; water gauge; and two test cocks. A hand pump is available for auxiliary feed purposes. The whole of the interior of the boiler can be exposed for inspection and cleaning by breaking the bolted joint between the shell and the firebox. No firebricks are employed, the firebox being water-jacketed.

Bakelite-Cased Pressure Gauge.—The form of the casing of the dial-type pressure gauge has persisted practically unchanged since the introduction of the Bourdon gauge, brass being almost universally employed. Messrs. Hopkinsons, Limited, Huddersfield, have recently standardised a new type of gauge in which the casing is made from strong black Bakelite. The casing has a high degree of finish, and the adoption of this material not only economises metal, but results in a handsome appearance which is enhanced by the style of figures on the dial, these being easy to read from a distance without being disproportionately large. The tube and mechanism are self-contained and are attached to a pedestal block not connected with the gauge back. The tube is made of phosphor bronze and is solid-drawn. The materials of the internal mechanism are resistant to wear and corrosion. A fixed stop is provided at the zero graduation. The new gauge can be readily adapted for mounting on control panels.

OIL-FIRED PORTABLE BOILER.

MESSRS. MERRYWEATHER AND SONS, LIMITED, GREENWICH.

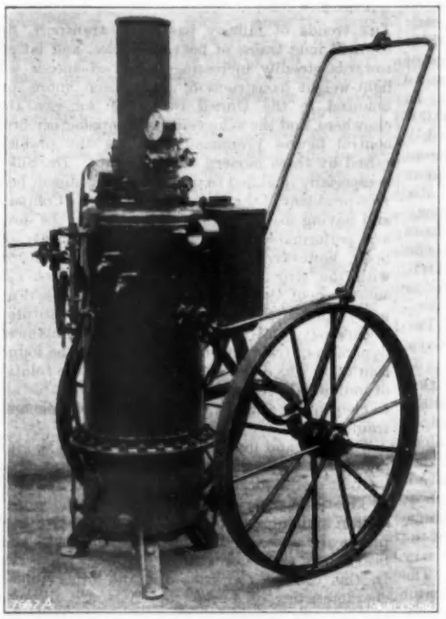


Fig. 1. Boiler on Wheeled Carriage.

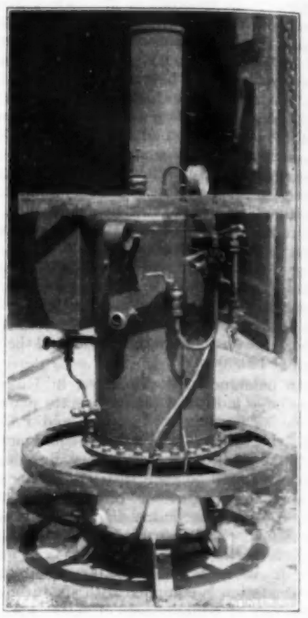


Fig. 2. Boiler in Working Position.

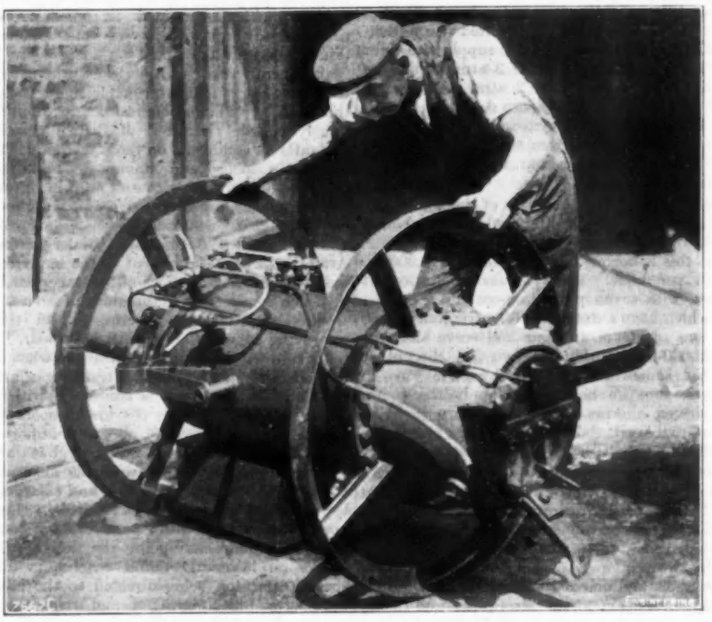


Fig. 3. Boiler being Transported by Rolling.

Licences for the Acquisition of Goods Vehicles.—Complaints have been made, we understand, that the Ministry of War Transport, in issuing licences to acquire new goods vehicles, fails to take account of the composition of the existing fleet of the operator concerned, with the consequence that an operator whose fleet consists entirely of vehicles of one type may receive a licence to acquire a vehicle of another type. As is well known by all applicants for new vehicles, the form on which the application is made (Form V.C. 1(G)) provides for a first, second and third choice. It is assumed that when an operator indicates that a certain make of vehicle is his first choice, he does so with due regard to the make up of his existing fleet. Opportunity is given, however, to indicate a second or third choice because, under war-time conditions, it is not always possible to ensure that a vehicle of any given make will be available within a reasonable time. The supply of certain classes of vehicles is extremely limited and far short of the demand. When the application is such as to justify the issue of a licence, the type of vehicle for which the licence is granted is decided firstly, by the order of choice, and secondly, by the availability of that type. It is assumed that where the first choice is not available, the applicant would prefer a licence to acquire the second or third choice vehicle rather than to wait for an indefinite period, until such time as a first choice vehicle can be supplied.

PNEUMATIC RIVETING MACHINE FOR LIGHT BOXES.

MESSRS. BROOM AND WADE, LIMITED, HIGH WYCOMBE.

FIG. 1. MACHINE ARRANGED FOR LONGITUDINAL SEAMS.

FIG. 2. MACHINE ARRANGED FOR END SEAMS.

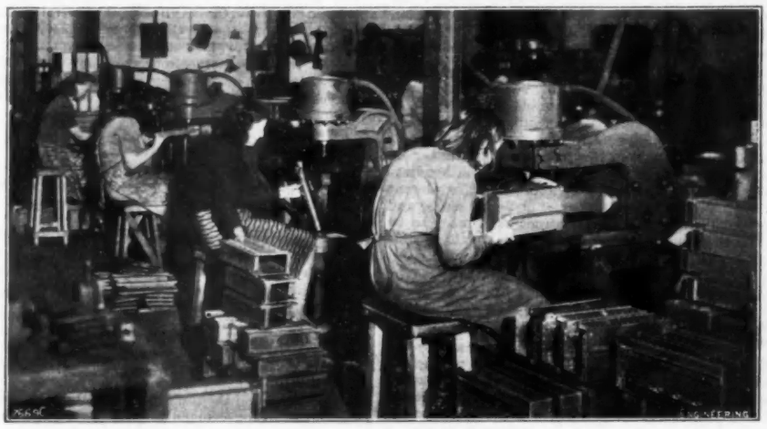


FIG. 3. GROUP OF MACHINES FOR SEQUENCE OF OPERATIONS.

RIVETING MACHINE FOR LIGHT BOXES.

ON page 716 of our 143rd volume (1937), we illustrated and described a pneumatic squeeze riveter manufactured by Messrs. Broom and Wade, Limited, High Wycombe, Bucks. This form was arranged for bench mounting and had pedal control, so as to leave both the operator's hands free, and the gap was of sufficient depth to admit work of normal dimensions. Certain products required at the present time, however, are somewhat unusual, among them being the ammunition magazines for certain types of aircraft seen in process of riveting in Figs. 1 to 3, on this page. As the magazines are of box shape and of considerable length, the standard type of yoke of the squeeze riveter is not suitable.

The machine shown in Fig. 1 has been modified for dealing with the longitudinal seams of the magazines by providing it with a fabricated steel yoke of increased depth and fitted with a substantial anvil bar over which the magazine is slipped. It is essential that the internal surfaces of the magazine should be perfectly smooth, so that countersunk rivets are used flush on the inside, the heads being closed from the outside. The rivets are inserted in the holes from the inside of the box and each is given a sharp blow by hand to retain it in place during the handling of the box. The closing operation is effected by holding the box so that the rivet is directly under the top snap. The short stroke of the machine then brings the rivet correctly down on to the bottom snap on the anvil bar. In the particular boxes illustrated all the rivets are $\frac{1}{4}$ in. in diameter and are of Duralumin.

The machine shown in Fig. 2 is also modified from the standard type. It is adapted for riveting the ends and the anvil consists of a vertical bar hinged at the base. The anvil bar is not visible in the illustration, but it has a cross-section such that rivets in the corners of the ends of the box can be reached, the bottom snap, moreover, being placed near one edge of the bar. In the machine shown in the centre of Fig. 3, however, the operator is swinging back the bar preparatory to placing a box in position for end riveting. The yoke of this machine, it will be noticed, is a casting and has a central hole so that a horizontal anvil bar can be inserted if required. The working parts of all the machines are similar to those of the machine described in the article referred above to, and they are known as the Broomwade type BSM 9 squeeze riveter. We understand that the use of these machines has resulted in an increase in production of 25 per cent. over hand methods with unskilled labour, but it is estimated that an increase of the order of 60 per cent. would be possible, if skilled labour were used.

MISCELLANEOUS CHEMICALS CONTROL.—The Ministry of Supply announces that responsibility for caustic potash, carbonate of potash, and lithopone has now been transferred to the Miscellaneous Chemicals Control, Iron Trades House, Grosvenor-place, London, S.W.1. The Controller is Mr. D. J. Bird.

RAW MATERIALS IN SWEDEN.

ACCORDING to a recent broadcast speech by Mr. Axel Gjöres, the Swedish Minister of National Economy, difficulties are being experienced in Sweden in obtaining sufficient raw materials to meet industrial requirements. Import restrictions, he said, had caused a shortage of coal and coke and had made it necessary, at a very early stage in the war, to limit supplies to industry. In May of this year, the total industrial coal consumption was reduced to only a third of the normal monthly consumption in 1939, and it had been cut down further during the summer. The cement industry, in particular, had been seriously affected by the shortage of coal. The steel output was slightly smaller during the first half of this year than in the corresponding period of 1940, and was less than the estimated needs of the country. Supplies of commercial steels, such as plates, were likely to be affected by the shortage of pig iron and scrap, though the situation was more hopeful in respect of special steels, owing to the elimination of several important export markets.

The supply of copper was limited, and it had been necessary to control its consumption, according to Mr. Gjöres. Arrangements had been made to increase the domestic production of copper by one-third. Strict economy was necessary also in the use of aluminium, but it had been possible to maintain the stocks by imports from Norway and Switzerland, with the aid of home production. A new aluminium factory, using Swedish andalusite, will be brought into use next year, with Government assistance; but, it was added, "domestic production is dependent on certain agents and raw materials that lately have proved difficult to obtain." Stocks of tin were relatively large, the Minister continued, but the prospects of obtaining more were practically nil. Lead was more scarce, but increased lead mining was projected, again with Government assistance. The possibilities of importing zinc were brighter, and production might be started in Sweden.

The requirements of sulphuric acid, nitric acid, hydrochloric acid and alkalies were covered by domestic production, but there was a shortage of some tanning materials, and of linseed oil. There was a deficiency of lubricants, and consumption had had to be restricted to about 60 per cent. of the normal. Efforts were being made to produce lubricants from home supplies of shale oil and wood tar. Rubber was very scarce, and the use of crude rubber had been cut down by a half. Textiles were being eked out with natural and artificial silk. The cultivation of flax had increased materially, and next year's crop was expected to cover 25 per cent. of the ordinary consumption.

GOLD PRODUCTION IN THE TRANSVAAL.—The Transvaal gold output in August (26 working days) was 1,212,708 fine oz., against 1,199,699 fine oz. in August, 1940 (27 working days).

INSTITUTION ELECTIONS.

INSTITUTION OF CIVIL ENGINEERS.

Associate Member to Member.—Arthur James Adams, M.Sc. (B'ham), Birmingham; Harry Brompton, B.Sc. (*Eng.*) (Lond.), Darlington; Randolph Edward Docwra, Surbiton, Surrey; Eric John Lawson Gibson, B.A. (Stanford, Cal.), Melbourne, Australia; Donald William Gollan, Madras, India; James Macfadzean, B.Sc. (Glas.), Glasgow; William Langston Newnham, Wellington, N.Z.; Jack Vickerman Oldfield, M.B.E., Grimsby; Savile Packshaw, B.Sc. (*Eng.*) (Lond.), London, S.W.1; John Reginald Roberts, Accra, Gold Coast, W. Africa; William Meilir Lloyd Roberts, M.Eng. (Liverpool), London, E.C.1; Henry Walter Stevens, B.Sc. (*Eng.*) (Lond.), Buenos Aires; Arthur Ayton Symington, B.Sc. (*Eng.*) (Lond.), Epsom, Surrey; Lewie Dewar Walker, Toronto, Canada; William Roy Watson, B.Sc. (*Eng.*) (Lond.), London, S.W.15.

INSTITUTE OF MARINE ENGINEERS.

Member.—William Henry Hull Bevan, Darlington; James Carnie, Manchester; Joseph Wilfred Coulthard, London; George Coutts, Aberdeen; William Garner, Calcutta; John Roy Holdsworth, Hull; Alan King, Bromborough; Arthur Percival Miles, Cardiff; Francis Taylor, Droitwich Spa; Andrew Marshall Warnock, Glasgow.

Associate to Member.—Karinchet Kunhen Kumaran, Ernakulam, India.

Associate Member.—George Moir Christie, Junr., Edinburgh.

INSTITUTE OF TRANSPORT.

Member.—The Hon. H. L. Lawrence Anthony, M.H.R., Minister of Transport, Commonwealth of Australia; G. L. Atkinson, Blyth; A. H. J. Bown, Sunderland; L. R. Christie, Grimsby; John Edwin England, Brisbane, Queensland; Rai Bahadur N. C. Ghosh, Calcutta; N. M. Hood, Newcastle-upon-Tyne; J. Ness, Edinburgh; J. A. Perdriau; C. S. A. Wickens, Luton.

INSTITUTION OF CHEMICAL ENGINEERS.

Member.—Clifford Marshall Auty, B.Sc., Dagenham, Essex; Paul Maurice Schuftan, Dr. Phil, London, S.W.1.

Associate Member to Member.—Arthur Turner Grisenthwaite, B.Sc., A.C.G.F.C., F.I.C., Stockton-on-tees; Charles Dodgson Walton, New York.

Associate Member.—Harry Allison, B.Sc., A.I.C., Merioneth; William George Atkins, London; Alan Stuart Bridgwater, B.Sc., London, W.C.2; William Walkden Goalen; Kenneth Ernest Humphrey, B.Sc., London, W.C.2; Francis Frederick Mooney, Manchester; Geoffrey Ogden, M.Sc., Manchester; Leonard Merritt Read, A.R.C.S., London, N.W.1; Tom Edgar Rule, Stockton-on-Tees; Clifford John Stairmand, B.Sc., Birmingham; Gerald Stott Tarboton, B.Sc., A.I.C., Pietermaritzburg, Natal; Trustham Frederick West, M.Sc., Ph.D., F.I.C., London, N.1.

Graduate to Associate Member.—Edward Joseph Eaton, B.Sc., a Royal Ordnance Factory; Hugh Neil Cameron MacLennan, B.Sc., A.I.C., Northern Rhodesia; Charles Albert Rock, Liverpool.

HINCHLEY MEMORIAL LECTURE.—The Fourth Hinchley Memorial Lecture will be delivered before the Institution of Chemical Engineers by Sir Richard A. Gregory, Bart., F.R.S., at the Institution of Civil Engineers, London, S.W.1, on Friday, October 24, at 2.30 p.m. Sir Richard's subject will be "Scientific Knowledge and Action." Non-members, who are invited to attend, should apply for tickets to the Assistant Secretary, Institution of Chemical Engineers, 56, Victoria-street, London, S.W.1.

PORTABLE GENERATING SETS.—As present-day conditions may involve an unexpected interruption of electrical supply, particularly where a factory has its own generating set, and the consequent loss of production may be serious. Until the normal supply can be resumed, the position may be improved by the temporary use of portable sets. Such a service is now being organised by Messrs. P.R. Engineering Company, Grandbuildings, Trafalgar-square, London, W.C.2, who, in conjunction with another firm carrying a stock of second-hand high-speed Diesel engines, is arranging for the mounting on suitable chassis of complete generating sets ranging from 10 kW to 150 kW, producing either direct current or alternating current of commonly-used voltages. These sets, disposed at depots in various parts of this country, will be available on a hire basis to meet an interruption in supply due either to enemy action or mechanical breakdown. A mobile power plant of this description might, moreover, be of great use in enabling the capacity of a plant to be increased to meet a temporary greater demand, or for supplying current while the normal plant is undergoing overhaul.

BRITISH STANDARD SPECIFICATIONS.

THE following specifications of engineering interest have been issued by the British Standards Institution. Copies are obtainable from the Publications Department of the Institution, 28, Victoria-street, London, S.W.1, and, unless otherwise stated, the price is 2*s.* net, or 2*s.* 3*d.* including postage.

Synthetic-Resin Bonded Fabric Sheet.—Hitherto the only specification relating to synthetic-resin bonded fabric sheet has been No. 668-1936, which deals with materials for use in the manufacture of gears. A new war-emergency specification, No. 972-1941, concerning synthetic-resin bonded fabric sheet for electrical and mechanical purposes, has now been issued. It deals with three types of sheet of thicknesses ranging from $\frac{1}{32}$ in. to 4 in. In type A, the number of threads per inch, warp and weft, is greater than 100, and the material has the highest mechanical strength and the best machining and punching properties. In type B, the number of threads per inch, warp and weft, is greater than 45, but less than 100, and the mechanical strength and machining and punching properties are intermediate between those of types A and C. In type C the number of threads per inch, warp and weft, is not less than 35, but does not exceed 45, and the mechanical strength and machining and punching properties are not so good as those of type B. The specification is divided into three parts, the first of which contains general clauses. Part 2 contains mandatory clauses to be applied to all material, whether for electrical or mechanical purposes, and Part 3 contains optional clauses which are to be applied when the purchaser specifically indicates that the material is for electrical purposes. The specification is based on information in the possession of the manufacturers and users represented on the special committee set up for the purpose, and not on technical data submitted by the Electrical Research Association. It is hoped, however, that a full investigation will be made in due course by the Association with a view to the revision of the specification and this explains why it is being issued as a war-emergency standard for the present.

Grading Rules for Structural Timber.—The recently-published British Standard grading rules for structural timber relate to 800 lb. flexure grade Redwood, Scots Pine, European Larch, and homegrown Douglas Fir. The term 800 lb. flexure, which is abbreviated to 800 lb. f., implies that, for the grade of timber so described, a maximum safe working stress, in bending, of 800 lb. per square inch is appropriate. The present specification (No. 940-1941) is the first of a series, and these publications will enable structural timber to be graded according to its strength, thus making it possible for designers of structures to utilise timber more economically than may have been the case hitherto. The specification contains data regarding permissible defects and an illustration of the different types of knot is included. In addition some useful information for users of timber in structures is given.

Electric-Cooker Control Units.—A second revision of specification No. 438-1941, dealing with electric-cooker control units—for use in two-wire circuits of not more than 250 volts declared voltage, has now been issued. It applies to units suitable for the control of domestic electric cookers having a normal demand of approximately 30 amperes, such units consisting of a switch for controlling the current to the cooker, together with an auxiliary circuit for other apparatus.

BOOKS RECEIVED.

The British Engineers' Association. Classified Handbook of Members and Their Manufactures. 1941 edition. London: Offices of the Association, 32, Victoria-street, Westminster, S.W.1. [Free.]

Mercury-Arc Current Converters. An Introduction to the Theory and Practice of Vapour-Arc Discharge Devices and to the Study of Rectification Phenomena. By H. RISSIK. Second edition. London: Sir Isaac Pitman and Sons, Limited. [Price 25*s.* net.]

United States Bureau of Labor Statistics. Serial No. R. 1318. *Shift Operations in Selected Defense Industries, March,* 1941. By MORRIS LEVINE. Washington: Superintendent of Documents.

Practical Cost Accounts Applicable to Various Industries, with Thirty-Three Graphs and Forms. By ANDREW MILLER. Osborne-road, Potters Bar, Middlesex: Gee and Company (Publishers), Limited. [Price 10*s.* net.]

United States Coast and Geodetic Survey. Special Publication No. 227. *Horizontal Control Data.* Washington: Superintendent of Documents. [Price 10 cents.]

United States Coast and Geodetic Survey. Special Publi-No. 876. *Surface Water Supply of the United States,* 1939. Part 6. *Missouri River Basin.* Washington: Superintendent of Documents. [Price 65 cents.]

PERSONAL.

MAJOR-GENERAL C. J. S. KING, C.B.E., M.Inst.C.E., is to be the first holder of the newly-created post of Engineer-in-Chief, War Office. Among the duties to be carried out by the Engineer-in-Chief are the general consideration of planning and control of engineering work for the Army; the control of the works services of the Army; arrangements for the provision of all engineering material and plant required in peace and war; and the liaison with the cognate civilian professions.

SIR A. VYVYAN BOARD, D.S.O., M.C., has been made chairman of the Salvage and Recovery Board, Ministry of Supply, and MR. G. HUTCHINGS, Director of Salvage and Recovery. The Board will deal with all questions relating to the salvage of waste materials and the reclamation of damaged products.

MR. J. S. NICHOLL, C.B.E., is to be installed as President of the Institute of Transport and will deliver the presidential address, at the opening meeting of the 1941–42 session of the Institute, to be held at the Institution of Electrical Engineers on October 13 at 5.0 p.m.

DR. P. CHISHOLM YOUNG, M.A., A.M.I.Chem.E., has been appointed plastics engineer in the works of Messrs. Boulton Paul Aircraft, Limited.

The Minister of Works and Buildings has appointed MR. A. T. GREEN, F.I.C., F.Inst.P., to be a member of the committee to advise on steps to be taken to increase efficiency and economy in the manufacture of bricks.

MR. J. R. PROBERT has been elected a director of Messrs. Henry Lees and Company, Limited, Glasgow. He has been made assistant managing director.

MR. R. H. ROBERTS has been appointed acting works manager of the Lancashire works of the British Tin Smelting Company, Limited.

MR. ROBERT BLACK, Scottish manager of Messrs. E. H. Jones (Machine Tools), Limited, Edgware-road, The Hyde, London, N.W.9, has now moved his office to 14, Quadrant-road, Glasgow, S.3 (Telephone: Merrylee 1345).

The directors of the Great Western Railway have appointed MR. K. W. C. GRAND assistant general manager; MR. L. E. FORD, assistant chief docks manager, Cardiff; and MR. D. G. HOPPINS, dock manager, Cardiff and Penarth Docks, on the retirement of MR. H. B. SMITH. MR. E. C. COOKSON has been appointed assistant to the chief engineer, Paddington, and MR. T. T. MEAD, divisional engineer, Newport, in succession to Mr. Cookson.

The Federal Technical University, Zürich, has conferred the Honorary Degree of Doctor of Engineering on DR. A. MEYER, technical director of Messrs. Brown, Boveri and Company, Limited, Baden, Switzerland.

NOTES FROM THE NORTH.

GLASGOW, Wednesday.

Scottish Steel Trade.—Active conditions continue in the Scottish steel trade. The demand for heavy steel is still strong and the orders on hand from shipbuilders and boiler makers represent a large tonnage. A feature of the industry at present is the amount of special alloy steels being specified and the use of this material is increasing. Despite the strong demand for the heavier and special kinds of steel, makers are managing to fulfil their commitments without any appreciable delay. In the black-steel sheet trade business is steady. The steel scrap position has not changed to any extent and although steelmakers have fairly good stocks any scrap coming into the market is quickly bought up. The following are the current quotations:—Boiler plates, 17*l.* 12*s.* 6*d.* per ton; ship plates, 16*l.* 3*s.* per ton: sections, 15*l.* 8*s.* per ton; medium plates, $\frac{1}{4}$ in. and thicker, rolled in sheet mills, 21*l.* 15*s.* per ton; black-steel sheets, No. 24 gauge, 22*l.* 15*s.* per ton: and galvanised corrugated sheets, No. 24 gauge, 26*l.* 2*s.* 6*d.* per ton, all for home delivery.

Malleable Iron Trade.—No notable change has taken place in the malleable-iron trade of the West of Scotland during the past week. Makers generally have a satisfactory amount of work booked. The re-rollers of steel bars, although fairly well employed, are not over-loaded with orders and can still give early delivery of new business. Wrought-iron scrap is scarce, but stocks of semies are very good. The current prices are as follows:—Crown bars, 15*l.* 12*s.* 6*d.* per ton; No. 3 bars, 13*l.* 12*s.* 6*d.* per ton; No. 4 bars, 13*l.* 17*s.* 6*d.* per ton: and re-rolled steel bars, 17*l.* 15*s.* per ton, all for home delivery.

Scottish Pig-Iron Trade.—Scottish pig-iron makers are still busy and as consumers are pressing for deliveries the current output is quickly absorbed. The demand from steelmakers for hematite and basic iron remains strong. Business in foundry grades of iron is fair and shows signs of improving. The following are to-day's market prices:—Hematite, 6*l.* 18*s.* 6*d.* per ton, and basic iron, 6*l.* 0*s.* 6*d.* per ton, both delivered at the steel works; foundry iron, No. 1, 6*l.* 5*s.* 6*d.* per ton; and No. 3, 6*l.* 3*s.* per ton, both on trucks at makers' yards.

NOTES FROM THE SOUTH-WEST.

CARDIFF, Wednesday.

The Welsh Coal Trade.—Means of increasing the coal production of the district were the subject of a conference called by the District Joint Production Committee and attended by one representative of the men and one from the management of every colliery in the area. Sir Evan Williams, Bart., chairman of the Joint Conciliation Board, presided and said that the suggestion for the conference was first made by Mr. Arthur Horner, president of the South Wales Miners' Federation. As a result of that suggestion similar conferences were to be held in every coalfield in the country. Mr. Horner said that production was roughly 10 per cent. below what the country consumed and had been endeavouring to accumulate for winter stores, and that a 100 per cent. employment at every colliery every day could not be secured. A percentage of absenteeism was inevitable. An important contribution to the reduced output rate was that both management and men retained the peace-time outlook, always conscious of what happened after 1921 and 1926, and afraid of prejudicing their positions in the future. After referring to the pledge given, to secure the withdrawal of the attendance bonus, that the miners' unions would deal with absentees, he went on to say that in the first place the pit committees would have such men brought before them and warn them. If the trouble continued the men would be dealt with by the authorities and not by the pit committees. The business that could be completed on the steam-coal market was again restricted last week. An active demand was circulating from inland buyers but most producers already had sufficient orders on their books to provide a steady outlet for almost the whole of their productions for some time to come. The tone, as a result, was very firm. Best large coals were almost entirely earmarked for contract deliveries, while offers of the sized descriptions were only very sparingly made. Bituminous smalls were again strong and extremely scarce, but some of the inferior dry steam smalls were obtainable without much difficulty and were dull.

The Iron and Steel Trade.—Activities in the iron and steel and allied trades, with the exception of the tin-plate industry which was restricted, were again well sustained last week. The demand for the various products was steady and order books were well filled for some time to come.

NOTES FROM SOUTH YORKSHIRE.

SHEFFIELD, Wednesday.

Iron and Steel.—Intense activity is evident in all the trades related to steel and engineering. A great amount of work is being done on Government account and to increase the outputs of certain types of products, operatives are working for longer hours. Eight-hour shifts have been converted into twelve-hour shifts, and Sunday working has been resumed in some cases. Conditions in the raw and semi-finished steel trades show a steady expansion. The demand for basic billets continues to increase although the inquiry for acid steel is more marked. Structural engineers are absorbing larger tonnages of the steels they require. The consumption of forge and foundry iron has been maintained on a fairly substantial scale, and producing works are operating at greatly increased capacity as compared with that at the commencement of the war. All types of scrap are in demand, and supplies are sufficient to meet requirements. Steelmaking al oys are in strong request. Rolling mills, forges, foundries, wire and rod mills and heavy machine shops are actively employed. Business is more brisk in railway rolling stock, and the output of wheels, axles, tyres, springs, and buffers shows a further increase. Activity in steelworks' and ironworks' machinery and related equipment shows no material change. Sheffield works specialising in the manufacture of all types of gold and silver mining equipment, crushing and grinding machines, and dredger parts are doing an increased trade on overseas account. Quarrying machinery is in demand on home account, and there is an improved market for road-making plant. Larger quantities of Sheffield-made high-efficiency steels are being supplied to centres concentrating on the production of internal-combustion engines. All kinds of engineers' small tools and machine tools are in strong demand, and some firms are having difficulty in supplying requirements.

South Yorkshire Coal Trade.—Larger quantities of coal are leaving the pits in this area for various parts of the country. Industrial coal continues in strong demand, and there is a better market for steams. Railway companies are taking larger supplies of locomotive coal, and are building up good reserves. The house coal market is more active, and householders are laying in stocks to cover their winter needs. Foundry and furnace cokes are steady, and there is an improved call for central-heating coke. Gas coke is more active.

NOTES FROM CLEVELAND AND THE NORTHERN COUNTIES.

MIDDLESBROUGH, Wednesday.

General Situation.—Extensive new business followed the issue of delivery licences for the last quarter of the year. The current exceptionally heavy production of iron and steel is promptly taken up, but bookings are not in excess of the output capacity and the supply is expected to be adequate for requirements of national importance now that non-war orders are rigidly excluded. Raw material is still plentiful and semi-finished products are in ample supply; there is no actual shortage of finished commodities. The position as regards scrap is improving, though imports have been considerably reduced. The reduction in imports has been offset by the increased tonnage of home scrap that has been recently placed at the disposal of the consuming plants.

Cleveland Iron Trade.—The increasing demand for foundry iron is promptly met, though scarcity of Cleveland brands continues. Deliveries from the Midlands and other producing centres are maintained at a level which enables some addition to be made to consumers' stocks. With business still mostly direct between makers and users, transactions passing through second hands, although increasing, cover smaller quantities than merchants could dispose of to their regular customers. There is no prospect of an early addition to the intermittent make of Cleveland pig, the fixed prices of which stand at the equivalent of No. 3 at 128*s.*, delivered to local buyers.

Basic Iron.—The output of basic iron is sufficient for the large and increasing requirements of consumers in this area, but provides no tonnage for use elsewhere. The recognised market value is 120*s.* 6*d.*

Hematite.—Little change can be reported in the hematite position. The shortage continues and delivery licences are granted only for essential needs. Meanwhile, the use of substitutes is gradually relieving the stringency. There is still no indication of any change in conditions that would permit an increase in production. Official quotations are ruled by No. 1 grade of iron at 138*s.* 6*d.*, delivered to North of England customers.

Foreign Ore.—Users of most kinds of foreign ore have good stocks and are regularly receiving satisfactory deliveries, but the difficulties in importing descriptions for the manufacture of hematite still remain.

Blast-Furnace Coke.—Negotiations in Durham blast-furnace coke are few. Sellers have large holdings, but are inclined to wait until they have reduced their contract obligations and local users are as well covered as they consider advisable. The fixed prices are firm at the level of 36*s.* 9*d.* f.o.r.

Manufactured Iron and Steel.—The tonnage of semi-finished iron and steel, stored at consumers' yards, is sufficient for several weeks' needs, but imports from overseas are practically stopped and considerably larger deliveries of local products are needed to keep stocks at their present level. There is a brisk demand from the re-rollers, all of whom are extremely busy and have more work in sight. Producers of finished iron could deal with more orders for light material, but are fully employed in departments turning out heavy work. The demand for plates is unabated and manufacturers of special alloy steels can scarcely cope with requirements. Railway requisites are in good demand and structural steels are the only commodities in less urgent request.

Scrap.—The supply of light scrap is fully equal to all requirements, but buyers of machinery metal, heavy steel and heavy cast iron, notwithstanding extensive purchases, have not covered their requirements and are anxious to place further orders.

CANADIAN REPRESENTATIVE OF MINISTER OF WAR TRANSPORT.—The Ministry of War Transport recently announced the resignation of Sir Edward Beatty, G.B.E., as Canadian Representative of the Ministry and of Mr. George Stephen, Assistant Representative. In accepting these resignations Lord Leathers has expressed to Sir Edward Beatty and Mr. Stephen his great appreciation of, and thanks for, the most valuable and arduous services which they have rendered since the outbreak of the war. The Ministry has gladly accepted Sir Edward Beatty's generous offer that the services and co-operation of the Canadian Pacific Organisation should continue to be at the disposal of the Ministry. The Minister, after consulting the Canadian Government, has appointed Mr. G. D. Huband to succeed Sir Edward Beatty as his representative in Canada as from October 1, 1941. Mr. Huband will have the assistance of a board consisting of the four existing directors who are members of the Canadian Pacific Organisation and of other members who will be appointed from among prominent representatives of the shipping community. The Offices of the Canadian Representative will be maintained at the Windsor Station of the Canadian Pacific Railway in Montreal.

NOTICES OF MEETINGS.

IT is requested that particulars for insertion in this column shall reach the Editor not later than Tuesday morning in the week preceding the date of the meeting.

INSTITUTION OF AUTOMOBILE ENGINEERS.—*London Graduates' Branch:* Saturday, October 11, 2.30 p.m., 12, Hobart-place, Westminster, S.W.1. Annual General Meeting. Informal Lecture on "Air Brake Equipment," by Mr. H. S. Shickle.

INSTITUTION OF ELECTRICAL ENGINEERS.—*North-Western Centre:* Saturday, October 11, 2.30 p.m., The Engineers' Club, Albert-square, Manchester. Chairman's Address, by Mr. H. C. Turner. *North-Eastern Centre:* Monday, October 13, 6.15 p.m., The Neville Hall, Westgate-road, Newcatle-upon-Tyne. Chairman's Address, by Mr. R. W. Gregory. *Scottish Centre:* Tuesday, October 14, 6 p.m., The Royal Technical College, George-street, Glasgow, C.1. Chairman's Address, by Mr. A. E. McColl. Wednesday, October 15, 6 p.m., The Heriot-Watt College, Edinburgh. Chairman's Address, by Mr. A. E. McColl.

MANCHESTER ASSOCIATION OF ENGINEERS.—Saturday, October 11, 2.30 p.m., The Engineers' Club, Manchester. Inaugural Address by the President, Mr. F. C. Anderson.

JUNIOR INSTITUTION OF ENGINEERS.—*Midland Section:* Saturday, October 11, 3 p.m., James Watt Memorial Institute, Birmingham. Annual General Meeting. *Institution:* Saturday, October 18, 2.30 p.m., 39, Victoria-street, Westminster, S.W.1. Ordinary Meeting. "Fire Fighting and the Engineer," by Mr. J. W. Stenson.

INSTITUTE OF TRANSPORT.—Monday, October 13, 5 p.m., The Institution of Electrical Engineers, Savoy-place, Victoria-embankment, W.C.2. Presidential Address, by Mr. J. S. Nicholl, followed by an informal reception.

INSTITUTION OF THE RUBBER INDUSTRY.—*London Section:* Monday, October 13, 6.30 p.m., Caxton Hall, Caxton-street, Westminster, S.W.1. "The Bonding of Rubber to Metal," by Dr. S. Buchan.

ILLUMINATING ENGINEERING SOCIETY.—Tuesday, October 14, 2.30 p.m., The E.L.M.A. Lighting Service Bureau, 2, Savoy-hill, Strand, W.C.2. Presidential Address: "Light and Lighting—A Forward Outlook," by Mr. W. J. Jones.

INSTITUTION OF ENGINEERS AND SHIPBUILDERS IN SCOTLAND.—Tuesday, October 14, 6.30 p.m., 39, Elmbank-crescent, Glasgow, C.2. Presidential Address, by Mr. F. C. Stewart.

INSTITUTE OF WELDING.—*Leeds and District Branch:* Tuesday, October 14, 7.15 p.m., The Great Northern Hotel, Leeds, 1. Lecture: "Shop and Erection Practice for Welded Structural Steelwork," by Mr. E. Fuchs.

INSTITUTE OF FUEL.—Wednesday, October 15, 2.30 p.m., The Connaught Rooms, Great Queen-street, Kingsway, W.C.2. Presidential Address: "The Hundred Thousand—An Engineer's Philosophy," by Mr. W. M. Selvey.

INSTITUTION OF MINING AND METALLURGY.—Thursday, October 16, 2.30 p.m., The Geological Society's Rooms, Burlington House, Piccadilly, W.1. General Meeting. "Some Notes on the Sub-Vertical Shafts, Vlakfontein Gold Mining Company, Limited," by Mr. R. B. Smart.

NORTH-EAST COAST INSTITUTION OF ENGINEERS AND SHIPBUILDERS.—Friday, October 17, 6 p.m., The Literary and Philosophical Society's Rooms, Newcastle-upon-Tyne. Annual General Meeting. Presidential Address by Mr. W. A. Woodeson.

INSTITUTE OF METALS.—*Birmingham Local Section:* Saturday, October 18, 2.30 p.m., The James Watt Memorial Institute, Birmingham. "The Welding of Light Alloys," by Dr. E. G. West.

INSTITUTION OF STRUCTURAL ENGINEERS.—*Yorkshire Branch:* Saturday, October 18, 2.30 p.m., The Hotel Metropole, Leeds. Address by the Chairman, Mr. H. A. Whitaker.

STOKE-ON-TRENT ASSOCIATION OF ENGINEERS.—Saturday, October 18, 6 p.m., at Messrs. Robert Hyde and Son, Limited, Stoke-on-Trent. "Some Recent Researches in Welding," by Professor F. C. Lea.

THE SALVAGE OF SUNKEN LOGS.—In the floating of timber down rivers, some of the logs become waterlogged and sink to the bottom. In Sweden, where many of the rivers are used for logging, attempts have recently been made to salvage some of this timber in order to use it as fuel. A commencement has been made on the River Angermanälven, at the bottom of which it is estimated there lie 2½ million logs. The work is being carried out by unemployed and is stated to have given promising results.

THE ADMIRALTY EXPERIMENT WORKS, TORQUAY.

(*For Description, see Page* 297.)

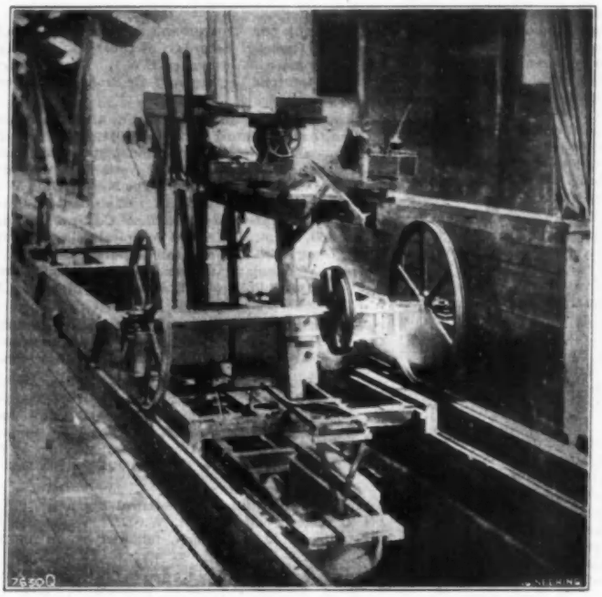


Fig. 31. Resistance Dynamometer Carriage at Start of Run.

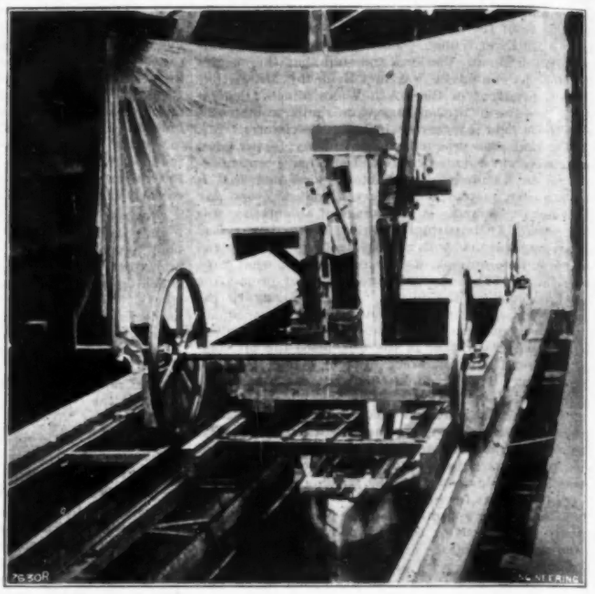


Fig. 32. Resistance Dynamometer Carriage at End of Run.

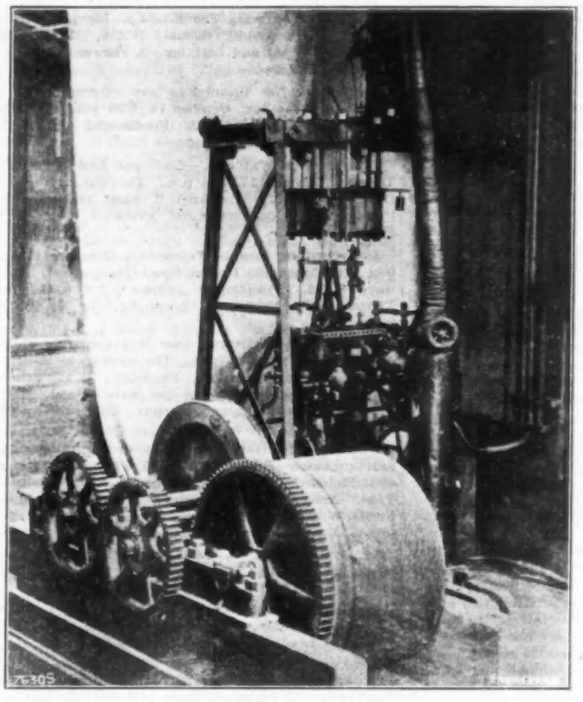


Fig. 33. Stationary Hauling Engine.

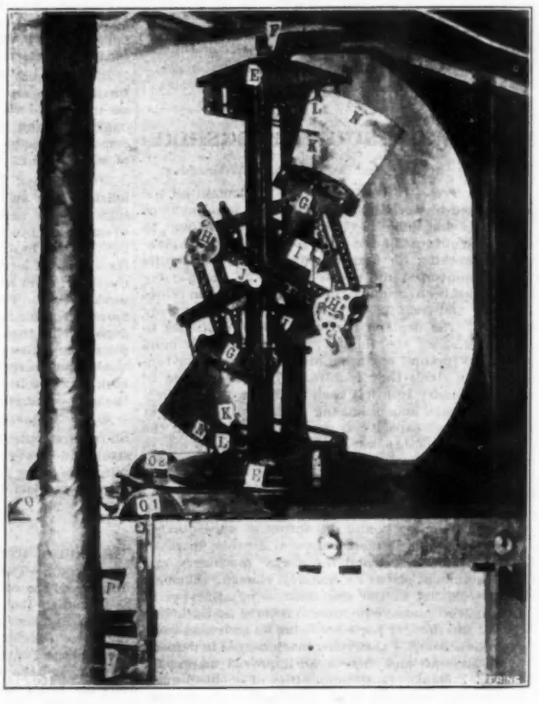


Fig. 34. Engine Governor.

Manufacture of Steel in India.—A memorandum issued by the India Office states that, except for special steels, the Indian steel industry is now able to meet nearly every requirement of India's Defence Forces, with a substantial surplus for allied countries. In addition to such products as rails and galvanised sheets, large quantities of special steels are being manufactured for the production of shells. Furthermore, bullet-proof armour plate is now being made for the bodies of fighting vehicles, and development work on the production of special alloy-steel sheets for the production of steel helmets is proceeding. The manufacture of steel mill rolls, hitherto imported, is now undertaken in India. It may be of interest to note that a new blast furnace, having a daily production capacity of 1,700 tons, has just been installed by a leading Indian steel company.

The Swedish Navy.—According to information recently published in Sweden, considerable additions have been made to the Swedish Navy since the commencement of the war. The new vessels include destroyers, torpedo-boats, submarines and minesweepers. The number of vessels delivered by Swedish shipyards or approaching completion, is stated to be 68, in addition to four destroyers and a number of motor torpedo boats acquired elsewhere. Several existing ships, including the cruiser Fylgia, have been modernised, and many merchant ships, whalers and tugs have been adapted for auxiliary naval purposes. A salvage ship is being equipped to deal with sunken submarines. Two cruisers have been laid down. No details of their dimensions or armament have been disclosed, but it is understood that they will be high-speed vessels and well armoured.

ENGINEERING.

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We desire to call the attention of our readers to the fact that the above is the address of our Registered Offices, and that no connection exists between this Journal and other publications bearing somewhat similar titles.

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ADVERTISEMENT RATES.

The charge for advertisements classified under the Headings of Appointments Open, Situations Wanted, Tenders, &c., is four shillings for the first four lines, or under, and one shilling per line up to one inch. The line averages six words. When an advertisement measures an inch or more the charge is 12*s.* per inch. Payment must accompany all orders for single advertisements, otherwise their insertion cannot be guaranteed. Terms for displayed advertisements on the wrapper and on the inside pages may be obtained on application. The pages are 12 in. deep and 9 in. wide, divisible into four columns, of 2¼ in. in width. Serial advertisements will be inserted with all practicable regularity, but cannot be guaranteed.

TIME FOR RECEIPT OF ADVERTISEMENTS.

Classified advertisements intended for insertion in the current week's issue must be delivered not later than first post on Wednesday. Alterations to standing advertisements must be received at least 10 days previous to the day of publication. Passed proofs must be in our hands by Saturday morning, otherwise they will be taken as correct. The Proprietors will not hold themselves responsible for blocks left in their possession for more than two years.

All accounts are payable to "ENGINEERING," Ltd. Cheques should be crossed "The National Provincial Bank, Limited, Charing Cross Branch." Post Office Orders should be made payable at Bedford Street, Strand, W.C.2.

TEMPORARY ADDRESS.

For the duration of hostilities, the Editorial and Publishing business of this Journal is being conducted from 18 and 20, Compton Road, Hayes, Middlesex. The Telephone Number of the Editorial Department is Hayes 1730, and that of the Publishing Department, Hayes 1723. The Bedford Street Offices are open on Fridays only, between 10 a.m. and 5 p.m., for the distribution of the current issue and for retail sales.

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ENGINEERING

FRIDAY, OCTOBER 10, 1941.

VOL. 152. No. 3952.

THE SCOPE FOR STANDARDISATION.

THE small paragraph headed "Standardisation of Hollow-Ware," which appeared on page 232 of our issue of September 19, while insignificant enough in itself, is of some interest as showing one effect of the war on everyday life and on some branches of manufacture which the general public are apt to take for granted. It recorded briefly that the Board of Trade had issued an Order (S.R. & O. No. 1345), entitled the Hollow-Ware (Control of Manufacture) Order, 1941, which provided for standardisation in the manufacture of hollow-ware in general demand, principally for domestic purposes; and that the Order would take effect on September 24. The hollow-ware affected includes such articles as pots and pans, pails, kettles, cans, buckets and bins of all kinds made of iron or steel, whether galvanised, japanned, enamelled or otherwise treated. The manufacture of such articles is prohibited, by the terms of the Order, except under licence of the Industrial Supplies Department of the Board of Trade and in accordance with the directions that will be given to manufacturers from time to time. By this means it is expected that, with the assistance of the trade, the supply of essential hollow-ware will be more economically maintained, and its manufacture will be simplified by the elimination of a number of sizes and shapes that are in comparatively limited demand.

It will be recognised that, considered solely from the point of view of standardisation, this Order and others of similar trend represent a fundamental departure from the basic principles of standardisation as applied by the British Standards Institution. They are purely war measures, designed to avoid overlapping and to economise labour and material and to some extent, no doubt, to facilitate the policy of concentration of industry which was adopted recently for the purpose of releasing man-power to meet the expanding needs of the Forces and the munitions programme. Inevitably, therefore, they involve official intervention in matters of design, which is the very form of interference that the original Engineering Standards Committee of 1901 and their present successors, the British Standards Institution, have always been at particular pains to avoid; except in the case of mere components, such as bolts and nuts, in which the requirements of interchangeability could only be met by standardising all the essential dimensions.

The guiding principles laid down by the British Standards Institution are, in their own words, to provide "a generally suitable standard of performance, quality or dimension and an equitable basis for tendering," and to "help to eliminate redundant qualities or sizes and enable manufacturers to provide stock during slack periods and purchasers to obtain their requirements more rapidly." The aim of the specification is to adopt "what is best in present practice," but "they do not interfere with individual initiative and invention, and they leave the producer as much freedom as possible in his methods of production." These principles have been followed as closely as possible, even in the special war-time specifications for A.R.P. material, etc., particulars of which we have published on numerous occasions during the past two years. It is a debatable point, however, whether the arbitrary control of design, implicit in the hollow-ware Order, should not be extended in the future as a means of expediting the replacement of many articles, the manufacture of which has had to be curtailed or temporarily discontinued as a war measure; and to what extent it might be justifiable as a permanent feature of standardisation policy, with or without the restriction of non-standard production.

There have been various indications, in sundry references in the daily Press, that some such policy is in contemplation. For instance, we understand that negotiations are now proceeding between the Ministry of War Transport, the Ministry of Supply, and the operators of public-service vehicles, to standardise the design of motor 'buses, to simplify manufacture and facilitate the supply of spare parts. No details of the extent of the proposed standardisation have been disclosed, nor whether it is designed to apply the eventual standards to motor coaches operating long-distance services, or merely employed on jobbing contracts, as well as to purely local transport concerns working on narrowly defined schedules. Presumably there would be at least two patterns each of single-deck and double-deck vehicles, to meet the requirements of urban and suburban services; and, in the case of the double-deck types, some effort would have to be made to determine a standard loading-gauge. The standardisation of lighting fittings, bells, route indicators, etc., presents no obvious difficulty, more especially as their manufacture was in comparatively few hands, even before the war; but if, as has been rumoured, the entire design and arrangement is to conform to a strictly limited number of national patterns, leaving no scope whatever for individual originality except in decoration, it is to be hoped that any Order making such standards compulsory will be subject to some definite time-limit. As a war-time measure, there is much to be said in favour of prohibiting minor modifications which might introduce undesirable complications in construction and maintenance; but the public-service vehicle cannot be said to have reached finality yet, rapidly as it has developed within the past ten years or so. Moreover, there are overseas markets to be considered. British manufacturers of public-service vehicles were well established in these markets before the war, and should be afforded every opportunity to re-establish their position when the war is over. It does not follow that a vehicle which represents the common denominator of home transport needs will succeed in attracting any extensive overseas custom if it has to compete (as it certainly will have to do) with designs specially prepared by builders in other countries to meet an exact specification. Britain has lost too many customers in the past through just such a lack of flexibility in design; and, as we have emphasised on former occasions, a nation that must live by trade cannot afford to be so preoccupied with domestic reconstruction as to neglect the re-habilitation of its commerce.

Motor 'buses, and pots and pans, are not the only directions in which the new standardisation is rumoured to be extending. Lord Reith has stated that the Ministry of Works and Buildings is engaged

on the standardisation of housing material; and even, we gather, on the design of standard houses. This is a prospect which is likely to arouse mixed feelings. In theory, there is much to be said for it, more especially for the establishment of a greater range of standard fittings than is available at present; so far as these are concerned, indeed, it would be possible to make out a good case for the standardisation of actual design in many instances. The common water-tap, for example, with its short-lived washer of rubber or fibre composition, should have been recognised long ago for the anachronism that it is, and compulsorily abolished in favour of the washerless variety. Admittedly, this is a minor point by comparison with the comprehensive standardisation of houses that is said to be in hand, but it would have avoided much waste of water and of pumping power if it had been enforced, as it might have been, before the big housing programmes of the past 15 years were undertaken.

Standardisation of such constructional details as doors and windows may prove to be less disturbing, commercially and æsthetically, than might appear at first sight; certainly, there is as much to be said for such a policy, undertaken on a national scale, as could be adduced in favour of the virtual standardisation on the basis of makers' catalogues that has obtained on many large housing estates. It is essential, however, that it should aim at the ideal of the British Standards Institution, namely, that of embodying the best in present practice; and that it should not exclude all opportunity for improvement.

There are many other directions in which a measure of design standardisation might be introduced with definite advantage, subject to the same safeguard. We have referred before to the openings that exist in agricultural mechanisation, a possibility that is touched upon again in the article by Mr. S. J. Wright which appears on page 294 of this issue. Railway rolling-stock, many kinds of ship fittings and equipment, motor cars, bottles and other containers for packed goods, to take a few instances almost at random, offer many opportunities for standardisation, the possibilities of which have been very incompletely explored. In most cases, some control over design may be necessary, and this may be the reason why more has not been done in these directions; but the changes in economic conditions that have already resulted from the war, and which are likely to persist for many years after it, may justify such interference now, even though they did not when the principle of non-interference was enunciated.

War-time regulation of industry may make it essential to limit the activities of manufacturers, and to prohibit other than a limited number of standard types of product; but when this embargo is lifted the mere existence of standards should not restrict materially the normal exercise of ingenuity in the production of new designs, any more than inventiveness has been affected in the past by the existence of earlier designs, many of long standing and proved popularity. At present, the Government have power to enforce the adoption of standard designs, although in practice the Ministry concerned would normally consult representatives of the industry affected, as the most obvious means of simplifying its own task. In peace-time, similar consultations take place before any new standard is formulated, and to a great extent, the same persons are likely to be concerned. There seems to be no reason, therefore, why various trade groups themselves should not agree on standard designs for specific purposes. If the standards are of a good enough quality, they will make their own market. If, on the other hand, there is obvious reluctance on the part of users to adopt them (as has happened in the case of some British Standard publications), and numerous departures from the standard are insisted upon, that should be sufficient proof that the standard is in need of revision. Fundamentally, however, there would appear to be some justification on economic grounds for extending to other manufactures, after the war, some such measure of direction—which is not the same thing as compulsion—as is now being applied in the case of domestic hollowware.

HEATING AIR-RAID SHELTERS.

The great majority of the air-raid shelters recently constructed are of the surface type. They are cheerless erections, and while no one is likely to suggest that their cost should be increased by the addition of decorative appurtenances, either inside or out, many will agree that, at least the larger examples, should, if possible, be provided with some form of artificial heating. The problem is different from that presented by underground shelters. These latter provide their own difficulties from the points of view of ventilation and damp, but do not exhibit the temperature fluctuations found in surface structures. The reason is obvious. The Building Research Station has given an average value of the thermal conductivity of subsoil as 0·293 and of dry brickwork as 6·66. These figures represent the number of B.Th.U. per hour per square foot per degree Fahrenheit difference in temperature per inch of thickness. Apart from this difference in conductivity, the underground shelter is protected from the direct action of the weather, while the surface structure is exposed to the full effect of cold air or snow.

Surface shelters, in general occupied during the coldest part of the 24 hours, present an unusually difficult problem to the heating engineer. Generally, they have four external walls, as compared with one or two of the average room in a dwelling-house. The ceiling is usually of concrete, which has a higher thermal conductivity than brickwork, and is directly exposed to the atmosphere; ground-floor rooms in houses are protected by the bedrooms above, and the bedrooms by a loft. The shelter floor is of concrete, the high conductivity of which results in rapid extraction of heat from the feet of occupants. The normal house floor is of wood. As the minimum standard of space specified for shelters is 50 cub. ft. per person, at least three changes of air per hour are desirable, whereas, owing to the greater capacity per person, the air-change in normal living rooms is about 0·75 per hour. The ventilating air enters at the bottom of shelters and is chilled by the concrete floor, or on cold days may chill the floor, with the result that the lowest part of the structure is the coldest, the extraction ventilators being fixed at the top. Such heating as is provided, added to the metabolic heat energy supplied by the occupants, rises to the upper part of the shelter, inducing a condition the opposite of what is desirable. "Keep your head cool and your feet warm" is good advice.

Various methods have been adopted for heating some of the larger surface shelters. These include radiant fires, hot pipes, and convectors of various types, but according to Mr. R. Grierson, who has inspected a number of installations, all exhibited the undesirable feature of minimum temperature at the bottom. In a paper entitled "Space Heating by Means of Electrically-Warmed Floors, as Applied to Surface-type Air-Raid Shelters," read before the Installations Section of the Institution of Electrical Engineers on September 18, Mr. Grierson supplied a detailed analysis of the factors which have to be dealt with in designing a heating system for surface shelters, considering the various points we have mentioned above in their quantitative aspects. The investigation which Mr. Grierson describes was carried out for the Northmet Power Company, and the shelter which was converted to floor heating, in accordance with the conclusions arrived at, was made available by the Civil Defence Committee of the Borough of Wembley. The shelter is of the semi-detached type, adjoining an identical structure on one side. It is 38 ft. 4 in. long, 10 ft. wide, and 8 ft. high, and is built to accommodate 50 persons by day, or 33, in bunks, at night. The walls are of 14-in. brickwork in cement mortar and the floor and ceiling of 6-in. concrete. The doors, at each end, are 1½ in. clear of the floor at the bottom, leaving a total area of 0·66 sq. ft. for the entry of air. The ventilators, five in all, consist of perforated bricks and provide a total extraction area of 0·243 sq. ft.

The natural interchange of air in the shelter was difficult to compute, as it appeared likely to depend to a large extent on the direction of the wind. When it was empty, or only sparsely occupied, it was estimated, however, that this might be taken as an interchange of 0·62 per hour. To be on the safe side, and to allow for the possibility that the doors might be left open, the heating installation was calculated on the basis of one complete change per hour for the empty shelter. This figure does not represent the interchange when the shelter is occupied. Air circulation in these conditions is assisted by the metabolic heat energy of the occupants. This gain, with 33 people sleeping in the shelter, is 3·86 kW. The total weight of the structure is about 60 tons, and the energy required to raise its temperature by 10 deg. F., assuming no loss of energy during the period of heating, was calculated as 78 kWh. This figure, however, does not make allowance for the free moisture in the brickwork, which was taken at 5 per cent. by weight of the weight of the structure. To evaporate this, 2,300 kWh were necessary. It is obvious that no form of heating installation in a surface shelter can provide a sensation of thermal comfort to the occupants within a few minutes of being put into operation, but a shelter in regular use will attain an average temperature higher than that of the empty structure owing to its heat capacity. This latter factor is of importance in connection with any form of electric heating, as it allows the use of off-peak power.

The floor-heating arrangements which were installed had a capacity of 3·36 kW and were designed to maintain a maximum temperature difference of 20 deg. F. above the temperature of the external air. On very cold nights this would not give a high internal temperature, but the majority of people using the shelter were not used to warm bedrooms and the conditions would not differ greatly from those to which they were accustomed. Soil-heating cable, of the type which is used for agricultural service for hot frames, was laid at 4 in. centres in the original concrete floor, the loading being 14 watts per square foot of floor area. This arrangement increased the floor thickness by 1¼ in. and even the small decrease in internal capacity which this represented would not be necessary in a shelter designed for floor heating from the first. Actually the effective space taken up by the installation was probably less than would be required by any form of localised heating, as there was no zone of high temperature which could not be used. Temperature control was provided by a rheostatic thermostat, and a standard time-switch was installed to cut the heaters out of circuit at the peak.

When the installation was completed it was subjected to an eight weeks test, the time-switch being set to cut off the current from 7 a.m. to 10 a.m. There were ice crystals on the lower side of the roof at the start and the inside of the shelter remained very damp for some weeks while the structure was being dried out. A small propeller fan was installed in the third week. This gave 5·6 forced changes of air per hour and by the fourth week the internal walls became reasonably dry. Runs with the fan in operation during the fifth week showed floor surface temperatures of about 70 deg. F., and an average temperature difference between outside and inside of 18·1 deg. F. The fan was then removed, and with natural ventilation of the empty shelter, estimated to provide an air change of 0·62 per hour, the difference between outside and inside temperature was found to be 19·3 deg. F. and the average temperature of the surface of the floor 63·6 deg. F. This lower temperature was explained by the reduction in energy consumption from 54·4 kWh to 50·7 kWh a day, the lower consumption being sufficient to maintain the temperature difference which was being aimed at. An important result of these tests was that the air temperature at the top of the shelter was found to be lower than at the bottom, the average temperature 10 in. below the ceiling being 57·9 deg. F. and the temperature 6 in. above the floor 60·4 deg.

Mr. Grierson points out that this floor-heating system involves the use of no iron or steel and that the man-hours of labour per kilowatt capacity involved in its manufacture and installation are probably the lowest for any form of heater.

NOTES.

RAILWAY OPERATION IN THE SECOND YEAR OF WAR.

A GENERAL survey of the work of the British railways during the second year of the war shows how various have been the problems arising, especially those resulting from the intensification of air warfare. Since September, 1940, the railway systems all over the country have seldom been entirely free from air attack, and their property has been frequently bombed. Through the heaviest air raids, the railways rapidly restored their tracks and services. In spite of the heavy strain to which they were subjected, the locomotives, rolling stock and equipment have stood up well to the exceptional traffic. Before the war, some passenger trains of 500 tons were operated, but, during the past twelve months, trains up to 700 tons have not been uncommon. According to the Chief Inspecting Officer for Railways, the risk of death to passengers in train accidents was only one in 30 million journeys. The railway catering services have been rationed as ordinary caterers, but have maintained in use some 400 restaurant cars, 89 buffet cars, and 507 refreshment rooms, in addition to platform trolleys. Facilities for members of the Forces included 137 canteens. The evacuation of women and children from London and other large centres of population has continued since the heavy air raids of last autumn and winter; and, as recently as August 28, trains were provided for 2,000 mothers and children from London stations. Lighting restrictions during black-out periods remain one of the biggest problems of railway working. Before the war, much railway operation was carried out by night, but, for the past two years, many railway centres have been without light for long periods. All the goods depots, marshalling yards, sidings, stations and trains are now equipped with the best lighting possible under the safety regulations. Modifications to train lighting have involved altering half a million lamps and shades and the re-equipment of 46,000 vehicles. In spite of the fact that the desired output of coal has not been attained, more coal has been regularly transported than ever before, hauls sometimes exceeding 300 miles. Changes in the distribution of industry, and the erection of hundreds of factories in new localities, have involved the transit of heavy volumes of traffic by routes and through junctions not originally designed to cope with them. Some branch lines are carrying ten times their normal peace-time traffic. The Inter-Railway Wagon Control, which came into operation at the beginning of March, 1941, has enabled the supply of wagons to be adjusted all over the country. The railways' A.R.P. arrangements have been thoroughly overhauled. Special fire-fighting locomotives and trains have been built, and full co-operation organised to deal with the effects of air raids. Elaborate arrangements exist for re-routing traffic to avoid congestion and to minimise the results of mishaps and bomb damage.

ADVISORY COMMITTEE ON INDUSTRIAL FUEL CONSUMPTION.

The Secretary for Mines has announced that he has set up a committee under the chairmanship of Dr. E. S. Grumell, M.I.Min.E., head of the fuel-economy department of Messrs. Imperial Chemical Industries, Limited, to advise the Government on the many technical aspects of efficiency and economy in industrial fuel consumption. The members of the committee comprise Mr. J. G. Bennett, Director of the British Coal Utilisation Research Association; Mr. W. L. Boon, M.I.Mech.E., F.I.Gas.E., general manager of the London and Counties Coke Association; Mr. W. J. Drummond, M.Inst.C.E., M.I.Mech.E., member of the central committee of the Mining Association and managing director of Messrs. Ashington Coal Company, Limited; Mr. E. V. Evans, O.B.E., M.I.Gas E., F.I.C., general manager of the South Metropolitan Gas Company and chairman of the Gas Research Board; Sir Clement Hindley, K.C.I.E., M.Inst.C.E., M.Inst.T.; Dr. R. J. Sarjant, of Messrs. Hadfields, Limited; Dr. F. S. Sinnatt, C.B., M.B.E., F.R.S., Director of Fuel Research, Department of Scientific and Industrial Research; and Mr. Johnstone Wright, M. Inst.C.E., M.I.E.E., chief engineer of the Central Electricity Board. We are informed that the committee is to work in conjunction with a staff of combustion engineers who have been placed at the disposal of the Mines Department by the Coal Utilisation Joint Council. In addition, the advice of the Coal Survey officers of the Department of Scientific and Industrial Research is being made available to the committee.

THE ARMAMENT SUPPLY DEPARTMENT.

THE Directorate of Armament Supply, of the Admiralty, attained the jubilee of its constitution as a naval department on October 1, having been constituted on that date in 1891. It is an offshoot or development from the Board of Ordnance, which dates back as far as 1414 and was originally a separate Department of State, responsible for providing and maintaining weapons for both the Navy and the Army. This was succeeded by the Army Ordnance Department (under the War Office), which continued to carry out these functions for the Navy until the introduction of guns that required mountings integral with the structure of the ships that carried them. When this development became general, it was found necessary for the Admiralty to have their own organisation, to be responsible to them alone for all matters, technical and financial. This new organisation was established in 1891 as a civilian branch of the Naval Ordnance Department, and became a separate directorate in 1937. It is charged with the provision, production, supply and maintenance of all guns, ammunition, torpedoes, mines, depth charges, etc., required by the Fleet, and maintains a number of factories and depots, both at home and overseas, staffed by a personnel which is now about twenty times as numerous as at the time of its formation. Rather curiously, no reference to this new development was made by Dr. (afterwards Sir) William Anderson, F.R.S., then Director-General of Ordnance Factories, in his address to the members of the Iron and Steel Institute on October 6, 1891, on the occasion of the visit to Woolwich Arsenal which was a feature of that year's autumn meeting. Dr. Anderson's address, which was reproduced in our issue of October 9, 1891, was "On the Constitution of the Royal Ordnance Factories" and referred incidentally to questions of naval stores and to the collaboration of naval officers with those of the War Department in the affairs of the Arsenal, but gave no hint of the considerable change that had just taken place in an administrative relation that had subsisted for some hundreds of years. Actually, the first head of the new branch was a former Army officer, Colonel Sir Thales Pease. He was followed in succession by four naval officers, namely, Rear-Admiral Sir Sydney Eardley-Wilmot, Captain B. H. Chevallier, Captain H. R. Norbury, and Captain H. J. Burnett-Hall. On the retirement of Captain Burnett-Hall, Mr. R. W. Wharhirst, C.B.E., a member of the Civil Directing Staff, took control, with the title of Director of Armament Supply.

THE NEWCOMEN SOCIETY.

The 1941-2 session of the Newcomen Society opened on Wednesday, October 8, when a meeting was held in the hall of the Chartered Institute of Patent Agents, London, W.C.2, at which two papers were presented. The first of these, by Mr. Sidney Withington, was entitled "Automobiles in 1830," though actually it began by quoting from the Book of Nahum and touched upon all the principal projects and experiments directed towards self-propelling land transport, from the Thirteenth-Century vision of Roger Bacon onward. The greater part of the paper consisted of judiciously selected abstracts from contemporary records, Parliamentary reports, etc., covering a wide field. Several were from the *American Railroad Journal*, with which the eccentric Zerah Colburn, founder of ENGINEERING, was connected. The second paper, by Mr. Noel Deerr, F.C.G.I., and Mr. Alexander Brooks, A.M.I.Mech.E., dealt with "The Development of the Practice of Evaporation" in the sugar industry. The survey covered the three phases of the process; namely, the period when evaporation was conducted over a direct flame, the intermediate stage when steam-heated appliances were used, and the ultimate development, primarily the work of Norbert Rillieux, of New Orleans, of multiple-effect evaporation. The paper was complementary to the earlier one by the same authors on "The Evolution of the Sugar-Cane Mill. At the Council meeting which preceded the ordinary meeting, 148 new members were elected. The programme arranged for forthcoming London meetings of the Society is as follows: The annual general meeting has been fixed for November 12, when, following the formal business, the presidential address will be read of Colonel C. E. Davies (secretary of the American Society of Mechanical Engineers), and also a paper, "Suffolk Windmills—Part I: Post Mills," by Mr. R. Wailes, M.I.Mech.E. On December 10, Dr. H. W. Dickinson will read a paper on "The Origin and Manufacture of Wood Screws," and Mr. W. A. Benton, F.P.S., one on "The History of Spring Balances." The two papers arranged for January 14, 1942, are "The Normands of Havre, Shipbuilders and Engineers," by Engineer-Captain E. C. Smith, O.B.E., R.N., and "The Evolution of Rider Planes for Aircraft," by Dr. A. P. Thurston. On February 11, there will be a paper by Mr. Rhys Jenkins, M.I.Mech.E., on "Early Engineering and Ironfounding in Cornwall," and another, by Dr. Herbert Chatley, on "The Development of Mechanism in China." The meeting on March 11 will be devoted to Mr. S. B. Hamilton's paper on "The French Civil Engineers of the Eighteenth Century," and Dr. H. W. Dickinson's on "Robert Stuart Meikleham." Dr. Dickinson is to read another paper, on "Joseph Bramah and his Inventions," on April 22, and, at the same meeting, which concludes the session, Mr. J. N. Goldsmith, M.Sc., and Mr. E. Wyndham Hulme, B.A., will contribute "A Sketch of the History of Natural-Draught Furnaces." The places of meeting will be announced in due course. The day is a Wednesday in each case, and the time, 2.30 p.m.

BRITISH HARD COKE ASSOCIATION.

At a meeting of representatives of coke-oven undertakings, held recently in London, arrangements for the organisation of the coke-oven industry were completed in order to enable that industry to make the maximum possible contribution to the war effort. As a result of the meeting, the British Hard Coke Association was formed, which body, we are informed, represents manufacturers responsible for 98 per cent. of the total production of the coke-oven plants in the United Kingdom. An executive committee has been formed to conduct the affairs of the Association and Mr. Ralph Alsop, C.B.E., has been elected chairman. The members of the executive committee are Messrs. W. J. Dobson, J. Y. Feggetter and G. W. Patrick, representing Durham and Cleveland; Messrs. G. A. Hebden, W. B. Archer, N. E. Webster, and G. E. Chicken, representing Yorkshire and Lincolnshire; Messrs. H. Watson Smith and F. Scopes, representing Derbyshire, Nottinghamshire, Staffordshire and Northamptonshire; Messrs. F. G. Macalpine and R. D. McCowan, representing Lancashire and Cumberland; Captain T. H. Thorneycroft and Mr. P. Baxter, representing Scotland; and Messrs. Ewart R. Evans, G. D. Budge and E. Julian Pode, representing South Wales and Monmouthshire. Mr. Leslie O'Connor has been appointed director, and Mr. F. Greenwell, secretary, of the Association. It is stated in *The Board of Trade Journal* that the Secretary for Mines has expressed the desire that this executive committee should act in an advisory capacity to the Mines Department.

THE JUNIOR INSTITUTION OF ENGINEERS.—The Council of the Junior Institution of Engineers has made a number of awards in respect of papers and lectures delivered during the 1940-41 session. These include the Institution Gold Medal to Mr. S. J. Moore, for his paper "Pipe Fittings and their Effect on the Efficiency of Supply Lines"; the Institution Silver Medal to Mr. P. A. Cartwright, for his paper "Protective Coatings on Metals"; the Vickers Gold Medal and Prize to Mr. A. S. Ladley, for his paper "Notes on the Mechanical Measurement of Liquid Flow (Water and Oil)"; the Tookey Award to Mr. R. H. Squire, for his paper "The Barakar Bridge Reconstruction"; and the Past-Secretary Dunn Medal to Mr. A. P. Morris, for his lecture "Papers and Discussion." The Midland Section Silver Medal has been awarded to Mr. A. W. Green, of West Bromwich, and the Sheffield Section Silver Medal to Mr. H. E. Cooper.

AGRICULTURAL ENGINEERING DURING THE WAR.

By S. J. Wright, M.A.

Before the war, progress in arable power farming could be estimated in either of two ways: by the overall extent to which mechanical power was being introduced, or by the success with which horse and manual labour were being eliminated from individual operations by a relatively small number of so-called "mechanised" farmers. Some of the achievements of these farmers, particularly in cereal growing, were highly spectacular, both in reducing labour requirements and in lowering production costs; but although labour economy in cereal growing is of the utmost importance to-day, it is from the first and simpler point of view that the progress of war-time mechanisation must be judged. The yardstick is the total number of agricultural tractors in use and their rate of increase, and the results over the past two years are highly impressive. In 1939, Great Britain had between 40,000 and 50,000 tractors and was adding something over 5,000 to their number annually. To-day there are close on 100,000 tractors. There has been a steady influx of over 500 new ones per week, and there is no sign whatever of a falling-off in farmers' demands for more.

That such a very rapid expansion of the tractor population has been possible is due almost entirely to the expanded production of the Ford Motor Company's plant at Dagenham. It follows that an overwhelming proportion of the new tractors are Fordsons, possessing few of the special characteristics towards which American manufacturers, and our own mechanised farmers, were tending in the immediate pre-war period. It is true that large numbers of special tractors, both tracklayers and row-crop machines, have been imported, and that there are indications of increased supplies in the near future; but the greater part of the food production campaign has depended so far, and will continue to depend, on ordinary wheeled tractors and on the ingenuity shown in adapting them to the extended requirements of war time.

A much bigger and more difficult problem than the supply of tractors themselves has been the supply of implements to go with them. In the first few months of the war there was a demand for ploughs beyond anything that home manufacturers could hope to supply in the time available, and the situation could only be met by mass importation of a few straightforward types. This cut right across the traditional British preference for a wide variety of different ploughs, each adapted, in theory at any rate, to particular local conditions of soil or cropping; but there was no alternative in the circumstances, and the results have more than justified the means. Much the same kind of thing has happened, in turn, with other implements: the enormous corn harvest this year, for example, has been cut mainly with imported binders. One implement in particular, the disc harrow, should be mentioned as being the discovery of the war in the eyes of a great many farmers. It is not by any means a new implement, but, due to its special virtues when grassland is to be broken up, there are at least twenty in use to-day for every one that was available in 1939.

It must not, be thought, of course, that all the new equipment has been imported. There are many essential items—such as ordinary harrows and cultivators, rolls, transport vehicles, and most haymaking machines—which have been needed in enormous numbers and the supply of which depends, as always, entirely on home manufacture. Moreover, apart from one or two special lines such as combine harvesters or pick-up balers, which are not manufactured in this country at all, the home production of everything that farming requires has been very materially increased. Yet it is very evident that the British agricultural engineering industry is not well adapted to meet sudden demands for an increased output or a rapid transfer of interest from horse to tractor equipment. The industry consists of a great many firms, large and small, scattered all over the country, and producing between them a very wide variety of types even of the simplest kind of implement. That so many types exist is due to the way that design has evolved over the past two centuries from the purely local ideas of progressive farmers and village craftsmen; and there may still be a great deal in the idea that, because soils vary from one locality to another, implements cannot be standardised. The lack of any beginnings of standardisation, however, is a great bar to expanded production at the moment, and will be a great handicap to the industry in the face of overseas competition after the war. Another immediate difficulty is that very few firms make all, or even the greater part, of the components of their implements, so that serious bottlenecks of production are liable to arise. Ten firms may each turn out their own patterns of cultivator, for example, and the tines of each may be different from those of the others; yet it is very probable that all the tines, whatever their pattern, will come from a single works in Sheffield. Again, agricultural implements have always depended to a very great extent on malleable castings; but supplies of these and of forgings come from the general engineering industry and at present involve a constant battle with the claims of other work of higher priority.

Whatever the difficulties, however, a very great achievement has been accomplished. Four million acres of broken-up grassland have been added to the pre-war nine million acres of arable land; the greatest corn harvest of all time has just been gathered, and plans are well forward for an even greater harvest next year. Although there have been temporary shortages which seemed desperate at the time, it is fair to say that the work as a whole has not been held up for want of machines. At the same time, there is no room for complacency, and there are plenty of difficulties still to be overcome. Thus, the equipment which suffices for planting a vastly increased acreage of corn may not be suitable or sufficient for keeping the land in permanent arable cultivation, growing the rotational crops that good husbandry requires. One instance has already been indicated by the difficulty of providing equipment for cultivating the greater acreage of potatoes which was demanded this year. In the ordinary way, potato cultivation is a matter either for horses or for specially-equipped row-crop tractors, neither of which could be suddenly produced in large numbers. Hasty efforts had to be made, therefore, to design and manufacture tool-bar equipment which could be used with ordinary Fordson tractors lacking the narrow adjustable wheels, the power lift device, and all the other features that would normally be required. These efforts were successful in the sense that they met the immediate situation; but much further development is needed before we can be self-sufficient as regards implements for potato cultivation. Incidentally, this is not a problem which could be solved by importing machines—not, at any rate, without completely altering present farming methods. Again, on the smaller farms—thousands of which have been brought into arable farming for the first time in living memory—a team of horses possesses some virtues which no ordinary tractor can emulate; for example, the ability to divide up so as to be in two or more places at the same time, and the ability to draw off a load from a heavy wet field straight on to the road. Finally, the harvesting of root and vegetable crops generally still needs more hand labour than can easily be found in war-time, and more than will fit into the picture of mechanised farming after the war. Some progress has been made; in particular, it is hoped that an appreciable part of this autumn's beet crop will be lifted mechanically. In general, however, progress in this side of mechanisation is lagging far behind.

Some reference must also be made to all the work of land reclamation and drainage that has been going on. The variety of work that has been, and is still being, undertaken is very wide. Hillsides covered with bracken and gorse have been brought under the plough for the first time in all history; mechanical equipment has rescued from oblivion the old practice of claying light fen land; thousands of acres of bush-infested downland have been cleared; and drainage work covering every kind of channel from farm ditch to main watercourse is being undertaken in every county of the kingdom. This kind of work demands the heaviest and strongest of agricultural equipment, the largest available imported tracklayers, and the heavy ploughs and cultivators that have long been made for export. In addition, it has demanded some of the equipment of the civil engineer and public-works contractor; the bulldozers, dragline excavators and other earth-shifting machines of which pre-war agriculture was hardly aware. Here, too, there are gaps in the equipment: there is hardly anything intermediate between the hand-wielded spade and the too-expensive bucket excavator for digging an ordinary drain trench, while the smallest available dragline is too cumbersome for the narrow winding farm ditch. Quite recently a massive cable-drawn trench plough has offered a hopeful solution of the first of these problems, although it will not be an easy one to apply on a wide scale in war-time.

One might sum up this brief review of war-time mechanisation by saying that great achievements have been made on the agricultural side; that implement manufacturers and importers have managed to keep within reasonable distance of the demand for more and more equipment; but that there is still room for ingenuity and far-sighted planning to meet future needs. It might have been easier for the present-day farmer if unlimited supplies of the special devices of the pre-war mechanisation expert—combine harvesters, balers, special tractors, and so on—had been available; yet, in the long run, British farmers and agricultural engineers alike may benefit from the efforts at improvisation which they are being forced to make.

OBITUARY.

MR. M. P. McLAREN, M.B.E.

We regret to record the sudden death, on October 2, of Mr. Maurice Paterson McLaren, M.B.E., of the engineering staff of H.M. Office of Works, and subsequently of the Ministry of Works and Buildings. Mr. McLaren, who was 62 years of age, was a native of Callander, Perthshire. He received his general education at George Watson's College, Edinburgh, and attended evening classes at the Heriot-Watt College while serving a five-years' indentured apprenticeship with Messrs. Bertrams, Limited, general engineers, of Edinburgh, with whom he had a varied training on the construction of paper-making plant, mill engines and machine tools. After completing his apprenticeship, he joined the staff of the Leith Corporation Electricity Department, serving for a year as switchboard attendant before being appointed mains assistant in connection with the electrification of the Leith tramway system. Subsequently he spent two years as shift engineer, but left the Corporation's service in 1903 on securing an appointment in the Office of Works, as assistant to that Department's Engineer in Scotland.

Mr. McLaren remained in this post for two years, towards the end of which he entered for the periodical District Engineers' examination, passing first on the list. He was then transferred to London, in charge of the Eastern District, but went back to Scotland eighteen months later as Engineer. Eventually he returned to London, where he had been principally engaged for a number of years on work in connection with Post Office buildings, including the heating, ventilating, etc., of the Central Telegraph Office at St. Martin's-le-Grand. Other important contracts for which he was responsible included the heating, lighting and ventilating arrangements at Holyrood Palace and at the National Gallery at Edinburgh; the heating and ventilating of the Admiralty Chart Establishment, Cricklewood; and the engineering equipment of the Government wool-disinfecting station at Liverpool, and of a number of large flax mills. During the last war, he was concerned with the provision and construction of anti-aircraft gun positions and searchlight installations for the defence of London. Mr. McLaren joined the Institution of Mechanical Engineers as an associate-member in 1921, and was transferred to the class of member in 1923.

LETTER TO THE EDITOR.

THE CONTROL OF POWER IN LARGE INTER-CONNECTED ELECTRIC SUPPLY SYSTEMS.

TO THE EDITOR OF ENGINEERING.

SIR,—If I have correctly understood Mr. Garrard's comments in his letter which appears in the current issue of ENGINEERING, I do not agree that the quantities derived by the calculations based on the diagrams of Fig. 62 represent no physical reality. The physical meaning which is to be associated with these calculations is that while one portion of the circuit-breaker structure has to withstand a certain current another part of the structure has to withstand simultaneously a certain pressure, and further, that while the current is being actually interrupted, the magnitude of this current will determine the conductivity of the path which is being subjected to the rising pressure. The use of the term "power," in the sense of reactive power, is a reasonable method of referring to a quantity which is expressed as the product of volts and amperes and can give rise to no misunderstanding in the context in which it is used. The calculations given in association with the diagrams of Fig. 62 are intended to emphasise these aspects in the light of the considerations of the physical phenomena involved in the rupture of the arcs in circuit breakers, which have been fully dealt with in previous sections of the article.

As regards the derivation of the numerical quantity for the capacity of the circuit breaker from the actual measurements taken from an oscillographic record, I would say that the purpose of giving these details is to provide useful information regarding the magnitudes of the quantities which actually obtain when a circuit breaker opens to rupture a short-circuit, and I believe that such information is much more illuminating and informative than a bald statement of the product of r.m.s. current and r.m.s. voltage. The full details of the calculation by which the figure given is arrived at, are clear and explicit, and as Mr. Garrard shows in his letter, the British Standard Specification rating of the breaker can at once be deduced from the data given; these data, however, give a good deal more information on the performance of the circuit breaker than a mere statement of the B.S.S. rating.

As regards Mr. Garrard's observations on the possibility of misleading a purchaser regarding the performance of the switch, surely this represents a rather naive attitude. Customers are entitled to have such oscillograms of circuit-breaker performance and there can be no excuse for their technical advisers being misled by any statement which the manufacturer may make on the interpretation which is to be given to these data. Provided full data are given, the interpretation according to the B.S.S. rating or according to any other standard specification rating, can be at once deduced from the information provided. Presumably, no prospective customer would purchase large power circuit breakers without the approval of a technical expert competent to interpret the test data provided.

Yours faithfully,

T. F. WALL.

University of Sheffield,
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October 4, 1941.

ACTIVITIES OF THE POST OFFICE.—During the first two years of the war the General Post Office has issued 2,400,000 mail bags, 204,000,000 lead seals and 1,200 tons of sisal twine.

TELEPHONES IN SWEDEN.—According to the annual report of the Swedish Telegraph and Telephone Office there was an increase of 45,000 in the number of telephones in use in Sweden during 1940. At the end of the year there were 890,000 instruments in use, this corresponding to 143 per 1,000 inhabitants. This figure, it is pointed out, places Sweden next to the United States in respect of the number of telephones per head of population.

RESEARCH.*

By the Hon. HERBERT HOOVER.

I WISH to take this occasion to urge again the immediate expansion of our research facilities in pure and applied science, and the more systematic application of what we already know in these fields. That is at all times the highway to increased efficiency and increased productivity. For the practical purposes of this discussion, pure science research means the search for fundamental natural laws. That is the search for truth. That is a good exercise any time. Applied science research is the application of such discoveries to practical use. That is invention. Pure science is thus the raw material of applied science. I do not want you to think I am building a rigid wall between pure and applied science. Their purposes and borders are much blended. I might mention another distinction between them: there are no big money rewards to the pure scientists.

I am not one who believes that the whole of civilisation is founded upon scientific discovery and the inventions. I could complain of a thousand economic and social ills that have come from the Industrial Revolution, including the increased capacity for mass-murder. But because of this war I can also tell you that unless we quickly have more of this same discovery and invention, and a more efficient application of what we already know, our standard of living and even our civilisation will degenerate. Whatever the outcome of these present wars, there is one thing certain—we shall have to divert a large segment of national energy to armament for years to come. That at once decreases the output of articles for public consumption. Unless we can, by some parallel action, increase our production of consumption goods, it means an immediate reduction in our standard of living. There is nothing that can so contribute to make up that deficiency as new discovery in pure science and new inventions.

There is another and immediate purpose of enlarged research. The aeroplane has revolutionised warfare. It has made the aggressor far more powerful. It has made small nations helpless to defend their liberties. The world has not yet found the defensive answer. The aeroplane was born from the science of physics. The answer might come from there. It imperatively demands research and more research—and at once; for, if that answer could come and come quickly, it would turn the whole fate of the world.

Whatever the outcome of this war, one more thing is certain—this whole world and our own country will be greatly impoverished and smothered with debt. There is only one certain road to rapid recuperation: that is to increase the technological power of the nation. It is increased productivity at lower costs that the nation will need. In the past we have always reaped such advantages from important discovery, invention and organised application. There is, of course, the commonly proposed idea that we could increase production and alleviate scarcity in goods by longer working hours; but it is far better that we accomplish this by more scientific discoveries, new labour-saving devices, new methods, or the more vigorous organisation and use of what we already know. I do not need to be told all the old arguments that invention puts men out of jobs. That ghost should have been laid when it saw the effect of the gas engine; for every man in the livery stable yesterday, there are 20 in garages to-day. Nor is there justification for that other truculent ghost which wails about more pressure upon individual workers. It only means that we work our machines and heads harder.

Our pure science research is dependent largely upon our universities and a few specially endowed institutions. Their research work is decreasing rather than increasing. The reduced interest return on the endowments of our institutions is driving them to cut into research rather than teaching. I doubt that, even without curtailment, their total resources for pure science research amount to 20,000,000 dols. a year. Thus we allow pure science a national expense account of about 5 per cent. of what we allow for cosmetics. We make a better showing in applied science. Governmental and industrial research, including agriculture, is supplied with probably 200,000,000 dols. a year. That is not equal to our cosmetics allowance by a good deal.

I can easily illustrate the movement of pure science from discovery to invention. Our electrical industries to-day are the result of search into pure science. They are the result of a half-century of step-by-step advance in the realms of pure physics and mathematics. It is from these realms that Faraday extracted the transformation of mechanical energy into electricity through induction. It is an old story that Gladstone was induced to visit Faraday's physics laboratory to see this new scientific contraption. When Gladstone, a practical man, inquired whether it would be of any use to mankind, Faraday opined, "I think some day you will be able to tax it." But it was long years afterwards that Edison, Thomson, Siemens and the other engineers translated Faraday's discovery into power and light. To-day it moans and groans with taxation; but it pays the taxes.

Taxes are not the major achievement of electricity. Rivers of sweat have been saved from the backs of men. Watt and Faraday did more to reduce the 84-hour week to a 44-hour week and to give more good jobs to men than all the laws and all the organisations which have been embattled in this cause. Infinite drudgery has been lifted from the hands of women. The electric light alone has relieved the human race from the curse of always cleaning oil lamps, scrubbing up candle drips, and everlastingly carrying one or the other of them about. And its benefits are not all economic. They lift the spirit. It adds cheer to life—enables us to postpone our spectacles for a few years longer. It has made reading in bed infinitely more comfortable. The doctors now peer into the recesses of our insides. Electric light has lengthened the hours of our active lives and enabled us to read the type in the telephone book. To return to the progress of skilled research in electrical physics. From Faraday we could move on to Maxwell's formulation of the electrical wave theory by pure mathematics. Hertz confirmed Maxwell in experiment and proved the radiation of waves through the air. It was the engineers Marconi and De Forest who transformed these discoveries of pure physics into radio communication.

What of the future? Are there any great fields to explore from which such benefits can spring again? The answer is that never in the whole history of fundamental science have there been so many vistas opened before us as right now. Discovery and invention expand in geometrical progression. Inventive minds play upon every new invention and breed a dozen more. Much of our progress comes from the invention of new instruments—that is, new tools for research. They are born from long hypothesis and prior experiment. Out of the discoveries in atomic structure and radiation have come new tools, new instruments, which open still wider avenues for research. By use of these laboratory tools or instruments comes a multitude of discoveries and inventions. Every time we get a new one we have some addition to human progress. In the very recent past, scientists have evolved a number of these instruments, the possibilities of which stretch our imagination to the breaking point.

The harnessing of the cathode ray through the cathode tube was the key to television. From that application the cathode tube was further developed to the astonishing new electron microscope. To-day we have photographs of red blood corpuscles as large as dish pans. We are actually able to photograph some molecules. From all of this we will know more of how to limit the conduct of bacteria and increase the energies of men. We will know far more about cellular structure and the make-up of molecules, which will improve industrial processes. The field of discovery with this instrument has hardly been entered. There will be scores of these in the hands of our scientists—provided someone furnishes the money to build and operate them. Then there are the Cyclotron and the mass spectrograph, and their opening of the whole vistas of atomic structure. Actual atomic power here has been experimentally produced.

These instruments are revolutionary; all advance in laboratory instruments is not so sensational. Minor ones happen every day which contribute to progress. The spectroscope was for years just a tool for the astronomer; to-day it has been transformed into an instrument for accurate metallurgical analysis, to control steel furnaces. Thus the methods of industry improve. The invention of the steam engine did not appear in the headlines of a world then engaged in the Napoleonic Wars, yet it saved the world from much of the impoverishment of those wars. History may yet record that the headlines of to-day should have been devoted to the inventions around the electron, rather than the war news.

Now I come again to the question of men and money for these explorations. I believe that every physical scientist in this country to-day could name new paths, new fields, that wait for the money to mobilise men and equipment. Many of their results may be sterile, but somewhere something comes—an improved instrument, a new path opens, and in the end there is an increase in the standard of living. Nor do we have to wait for pure science research to give birth to new laws, new instruments, new methods, new power, and new labour-saving devices. In many directions we sorely need support for research in the application of pure science discoveries we already know. One of the greatest problems right now is to develop more industrial raw materials, which farmers can produce in substitution for their over-production of food. I doubt whether we are spending five million dollars a year

* Address delivered at Haverford College, Haverford, Pennsylvania, on June 7, 1941. Abridged. From the *Journal of the American Society of Naval Engineers*, vol. 53, page 591 (1941).

looking for them; and we are compelled to subsidise the farmer with a billion a year and to regiment him besides until we find some such solution as this.

In the realm of industry there are further vast possibilities in synthetic fibres, rubber, plastics, or new sources and methods of making and using cellulose and a score of other things. There is the field of metallurgical treatment of low-grade ores. If we developed such methods, we could free ourselves from depending upon imports of chrome and manganese. We need substitutes for materials required for defence. I doubt if three millions a year are being spent in such research laboratories. Under the pressures of emergency, we can increase national efficiency through the elimination of existing industrial waste of motion and materials. That requires that we remove every sort of restriction, both by capital and labour, which impedes or penalises the use of better methods and better machines or the working of these machines full time. We will spend 20 billion dollars a year on armament, and pile most of it up in national debt. If we would invest 1 per cent. of this in an insurance policy called research and elimination of waste, we might save some of the bankruptcy when these wars die.

It is not beyond human imagination that the quiet, unobtrusive scientists and engineers in their laboratories might make all nations self-contained in raw materials and their production of goods. That brings me to another phase. We have been told with monotonous repetition by the collectivists and left-wingers that our frontiers are gone. They say our industrial plant is built, that there is no safety valve for human energies. They assure us that we have come to an age of humdrum problems of under-consumption, overproduction, and the division of the existing pot. They say that new opportunity for youth has shrunken. That is not so. There was never in history a more glorious frontier for youth than to-day. Adventure and opportunity beckon in every inch of science.

SURFACES FOR ROADS.

Changes in the distribution and intensity of road traffic as a result of war conditions have imposed heavy burdens on many roads that were never designed to carry them; but, in the absence of opportunity, and perhaps of the usual materials, for a thorough reconstruction, the work of maintenance must differ in some respects from peace-time practice. In war, too, there are numerous examples of road and similar types of construction—for instance, the interior communications of large factories, aerodrome runways, etc.—in which urgency demands some modification of the standards laid down as necessary for permanent works. To meet such requirements, the Road Research Laboratory of the Department of Scientific and Industrial Research, acting in co-operation with the Ministry of War Transport, has begun the compilation of a new series of pamphlets under the general title of *Wartime Road Notes*. The first of these, recently published by H.M. Stationery Office, Kingsway, London, W.C.2, at the price of 6*d*. net, contains "Recommendations for Tar Carpets and Surface Dressings."

The recommendations contained in the leaflet are based on systematic full-scale trials undertaken by the Department jointly with the Ministry of Transport (as it then was) and the British Road Tar Association, extending over many years, and supported by laboratory investigations. They embody the latest results of this research and experiment, combined with the lessons of experience; and, while it is pointed out that they do not represent by any means the last word in the classes of road construction discussed, they should yield good results if carefully followed. It is not intended, however, that they should supersede specifications for tar carpets which are already giving satisfaction. Recommendations are given for tar carpets made with crushed rock or with gravel, and for surface dressings using tar binders; though the point is emphasised that one is not a substitute for the other, and that a surface dressing cannot be expected to restore the riding qualities of a road that has a bad profile or other variations in surface level. For tar carpets, the use of crushed rock is preferable; but circumstances may arise, especially under war conditions, when gravel must be used. The recommendations apply to carpets not less than $\frac{3}{4}$ in. thick, and cover the materials, the mixing procedure, and the laying of the materials on the road. Specifications have been published already, by the British Road Tar Association, for tar carpets including a material of 1 in. minimum thickness, made with $\frac{1}{2}$-in. aggregate; the grading specified for it is similar to that recommended in the present leaflet for $\frac{1}{2}$-in. crushed rock, except that the maximum size of the aggregate is increased. The section relating to surface dressing includes a summary of the factors which determine the useful life of a road so treated, and a table setting out the requirements to which the tar binder should conform.

LABOUR NOTES.

In the industries for which statistics are regularly compiled by the Ministry of Labour and National Service the changes in rates of wages reported to have come into operation in August resulted in an aggregate increase estimated at about 58,000*l*. in the weekly full-time wages of about 415,000 workpeople and in a decrease estimated at about 4,600*l*. in those of 267,000 workpeople. The workpeople whose rates of wages were reduced had received increases of greater amount during earlier months of the year. The changes reported in the first eight months of 1941 are estimated to have resulted in a net increase of about 1,480,000*l*. a week in the wage rates of over 7,300,000 workpeople. In the corresponding eight months of 1940, over 7,400,000 workpeople received a net increase estimated at about 1,700,000*l*. a week. The particulars given exclude changes affecting Government employees, agricultural labourers and shop assistants and clerks, for which classes the information available is not sufficient to form a basis for statistics. The estimates of the effects of the changes on weekly wages are based on normal conditions of employment and do not take into account the effect of overtime working, etc.

Of the August increase of 58,000*l*. a week about 190*l*. was due to the operation of sliding scales based on fluctuations in the proceeds of the coal-mining industry, 53,350*l*. to arrangements made by joint standing bodies, 10*l*. to the operation of sliding scales based on the cost of living, and 100*l*. to arbitration awards. The remaining 4,350*l*. was the result of direct negotiations between employers and workpeople or their representatives. Of the August decrease of 4,600*l*. a week, about 3,800*l*. was due to the operation of sliding scales based on the cost of living and the remainder to sliding scales based on fluctuations in the proceeds of the coal-mining industry.

The number of trade disputes involving stoppages of work, reported to the Ministry of Labour and National Service as beginning in August, was 94. In addition, four disputes which began before August were still in progress at the beginning of that month. The approximate number of workpeople involved in these 98 disputes (including workpeople thrown out of work at the establishments where the disputes occurred) was 22,000 and the aggregate duration of the disputes in August was about 44,000 working days. The aggregate duration of all disputes in progress during the first eight months of 1941 was about 760,000 working days, and the total number of workpeople involved in these disputes about 225,000.

The conference of the International Labour Organisation which was mentioned in these Notes a week or two ago, is to be held in Columbia University, New York. It will open on October 27, and a full delegation of Government, employers' and workers' representatives will attend from this country. Mr. Ralph Assheton, M.P., Parliamentary Secretary to the Ministry of Labour and National Service, and Sir F. W. Leggett, the Minister's chief industrial commissioner, will be the Government delegates, and will have Mr. A. S. Frere and Mr. H. F. Rossetti, of the Ministry, as advisers. Sir John Forbes Watson, director of the British Employers' Confederation, the employers' delegate, will be accompanied by Mr. H. S. Kirkaldy, general secretary of the Iron and Steel Trades Employers' Association and Mr. A. C. Low, secretary of the Engineering and Allied Employers' National Federation, as advisers. Mr. Joseph Hallsworth, of the Trades Union Congress General Council, the workers' delegate, will have Mr. George Gibson, ex-president of the Trades Union Congress, and Mr. George W. Thomson, of the Trades Union Congress General Council, as advisers.

On the motion for the adjournment in the House of Commons on Thursday last week, Mr. J. Griffiths, the Labour Member for Llanelly, raised the question of the amount of food supplied to workpeople engaged in the production of war materials. In many cases, he said, the food these workers were able to obtain was inadequate in relation to the work they had to do. Extra food rations should be given to workers in heavy industries such as coalminers, steelworkers and quarrymen. It was wrong that catering establishments serving the heavy industries should be allotted supplies on the same basis as restaurants in the cities. Speaking as a steelworker with 25 years' experience, Mr. Mort, the Labour Member for East Swansea, said that the problem of providing extra food for the heavy worker must be solved in some way or there would be a serious breakdown in the health of that part of our industrial population.

Dealing with the point raised by Mr. Griffiths, Major Lloyd George, Parliamentary Secretary to the Ministry of Food, recalled that the policy of the Government had been to allow the maximum possible rations to consumers generally, rather than give a supplementary ration to any particular class at the expense of the rest of the community. After very careful consideration of all the facts and advice, the Government proposed not to alter that policy. That did not mean that the Ministry did not accept the need for a supplementary ration for men and women who were engaged in the heavier industries.

Addressing a meeting of the Glasgow and West of Scotland Division on Wednesday last week, Mr. George W. Lucas, President of the Motor Agents' Association, said that the large expansion of mechanisation in the Armed Forces would necessitate a further call on the skilled man-power of the industry, and he was convinced that workers would have to be trained and employed on a scale not hitherto contemplated. Some vehicle repairers were already employing women.

Proceeding to emphasise the vital part which the motor-vehicle repairing industry had to play, Mr. Lucas stated that much war production work depended upon road transport, which must be maintained in an efficient state. Shortage of labour, both skilled and semi-skilled, was the biggest problem the industry had to face, but the fact that wages and conditions of employment in the industry were now stabilised, under the agreement entered into between the Association and the trade unions, would considerably help the position. It was the national duty of repairers, he added, to train "green" labour to the maximum of their capacity.

According to the *Manchester Guardian*, there is still a considerable shortage of men for war industries in the North-west regions. Over 150,000 have actually been registered, but when each case came to be considered, it was found that about 120,000 were already engaged on work of national importance or were covered by the Schedule of Reserved Occupations. That left about 30,000 who were interviewable. In the course of the interviewing, about 10,000 of these men were discovered to be already on work of national importance, many of them having given incomplete information about their employment in the first instance or having transferred to war work after registration. To date, 7,000 have been found who are available for transfer to war work and have been, or will be, served with notices. About 9,000 were considered unsuitable for transfer, and the cases of the remainder were deferred for further consideration.

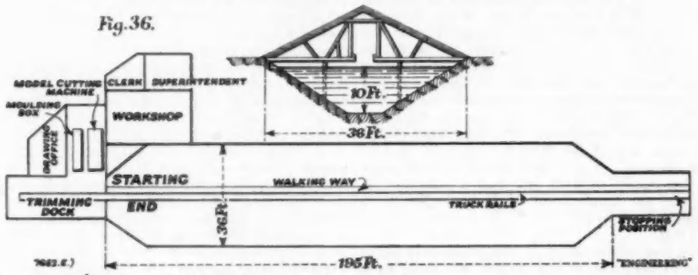
The North-Western Regional Board Production Executive is seriously concerned about the small number of women who have been trained and are employed by engineering undertakings in the area. In the course of a letter which he has circulated to employers, Sir Frederick West, chairman of the Production Executive, says that the Board is fully conscious of the respective demands for men and women for the Forces and for the war industries. The claims for the Forces will not, it is realised, diminish. On the contrary, it is pointed out, owing to the necessity of maintaining the vast mechanical equipment of the three Services, the call for skilled men becomes more and more urgent. The demand for skilled men for new and extended factories was also far from satisfied, and the older-established firms would have to release still more men for employment in such establishments

"Very many large and important engineering firms," Sir Frederick West goes on to say, "have considerably extended their employment of female labour. Others have only commenced during the war effort. But the Board views with concern the apparent reluctance of many firms to employ women at all, and it is felt that if this region is to maintain its proper position in the war effort there must be a considerable extension of the employment of female labour. The number of firms in this respect must show a marked improvement. . . . It has been proved conclusively that female labour, as a substitute for male labour, has been successfully introduced to a wide range of mechanical operations and works' activities, and whether it is trained in firms' own works, Government training centres, or technical colleges, there is plenty of evidence as to its usefulness."

"The Board, therefore, strongly urges," the letter states, "if you have not yet resorted to female labour, that you should do so at once, or if you have done so, that you should consider an extension, as it is fully satisfied that the fulfilment of the demands of the Forces and the war industries for skilled men can be achieved only by this policy."

THE ADMIRALTY EXPERIMENT WORKS, TORQUAY.

FIG. 35. TORQUAY EXPERIMENT TANK.



THE ADMIRALTY EXPERIMENT WORKS, TORQUAY.*

By R. W. L. GAWN, R.C.N.C.

(*Concluded from page* 240.)

Appendix I.—Description of the Tank and Equipment.—The Admiralty Experiment Works at Torquay were situated in a field separated from the garden of William Froude's house, Chelston Cross, by Seaway-lane, which connects the road from Torquay to Paignton with Cockington Village. The establishment consisted of a covered waterway, office, and workshop, housed in a wood building, as shown in Figs. 35 and 36, herewith, with a brick boiler-house. Wood construction was suited to the building, which had to be cheaply erected for temporary purposes only and then removed to enable the site to be cleared and the land made good as required by the lease. The works lasted, in fact, for over 14 years, but the conditions of the original lease were eventually fulfilled, and now nothing remains to show the use to which the ground at one time was put.

The waterway was a canal, formed partly by excavation and partly by an embankment raised from the material excavated, 278 ft. long (of which about 165 ft. was of uniform section), 36 ft. wide at the water surface and 10 ft. deep. At its end it narrowed and shelved, giving water channels about 9 ft. wide and 3 ft. deep. The comparatively large width at the top was arranged by Froude so that "it was above all suspicion as to waves set up by the motion of the body." The sloping earth sides were puddled and surfaced with asphalt to prevent leakage and, to quote from one of the Reports of Progress, "protect the foreshore or beach against the artificial waves which have to be created in an important branch of the experiments." There is no evidence of experiments in artificial waves having been made at Torquay, although a working drawing of a wave-maker is in the records. This drawing shows an oscillating plane on the same principle as that now in use at Haslar, but no provision was made for power operation.

A railway of 3 ft. 3 in. gauge, on which the model resistance and screw dynamometer carriages ran, was carried by the roof principals and extended the full length of the waterway. This arrangement enabled the carriages to be of light construction and helped materially in keeping down the cost of construction. The resistance carriage (Figs. 31 and 32, on page 290), could be run either independently of, or connected to, the screw carriage and was hauled by an endless wire rope wound on a barrel driven through spur gearing by a stationary steam hauling engine at the starting end (Fig. 33, on page 290). A small carriage was provided, for attaching to the rear of the resistance carriage, from which the wave formation at the stern of a model could be observed at close quarters. The two-cylinder stationary steam engine, specially designed by William Froude, assisted by Mr. Beauchamp Tower, to exert a uniform tractive force, was made in his workshop, and hauled up to a speed of 1,000 ft. per minute. A sensitive isochronous governor of the centrifugal type (see Fig. 34, on page 290) regulated the speed variation to within 0·5 ft. per minute. The accelerative power of the engine could be supplemented by attaching to the resistance carriage a rope and suspended weight, provided with a suitable fall into a pit outside the building.

Hard paraffin wax, referred to in some of the early records as stearine, was used from the beginning as the material from which the models were made. The remarkable advantages of this material for the purpose are fully reviewed in a paper by William Froude* and have been confirmed by 70 years' experience. The addition of a small percentage of beeswax, to prevent the formation of air holes in the finished surface of the model, was suggested in the discussion on the paper. This became general practice later and has been continued since, thus obviating recourse to the burnishing process for filling up the air holes. In the same paper the model-shaping machine and method of trimming are also fully described, the latter remaining practically unaltered to-day. It speaks well for the capacity of the Establishment that a model over 18 ft. long was made on one occasion, but generally the length was restricted to about 10 ft. It is a remarkable tribute to Froude's foresight and accuracy that the process of model-making in paraffin wax has persisted to this day without substantial modifications. Naturally the modern shaping machines embody improved details, including power drive for the model table and other devices, but the only two changes of note are, first, that the cutters are now raised and lowered to suit the different level lines of the model, instead of the model itself being adjusted to different heights; and, secondly, the drawing table is now horizontal or inclined at a small angle to the horizontal, instead of being vertical as in the first machine. These modifications were introduced by R. E. Froude in 1887 in the then new machine installed at Haslar. Moreover, the principle of automatic records of the model experiments with electric time, distance, and current records is still in general favour substantially as at Torquay, although naturally experience has resulted in many refinements of detail being embodied.

Appendix II.—Formulæ for Resistance of Shaft Brackets and Shaft Tubes (see page 160, *ante*.).—For twin-screw shafts: Resistance (tons of both shafts $= \frac{b\,d\,V^2}{10{,}000}$; where b = the mean distance in feet of either shaft from middle-line plane, d = the shaft diameter in feet; and V = the speed in knots. For shaft bracket arms of twin-screw shafts: Resistance (tons) of two brackets $= \frac{b^3\,V^2}{60{,}000}$; where b = distance in feet of centre of screw from middle-line plane. This formula assumes total length of strut as $3\,b$, and average thickness $0{\cdot}054\,b$. For other values, resistance is assumed to vary as thickness and total length.

* Paper presented to the Institution of Naval Architects. Abridged.

* "Description of a Machine for Shaping the Models used in Experiments on Form of Ships." *Proc.I.Mech.E.* (1873).

WAR-TIME ECONOMIES IN ROAD MOTOR TRANSPORT.

AN exhibition of some war-time activities of the Road Motor Department of the London Midland and Scottish Railway, held at Euston Station recently, was of interest in showing, apart from certain vehicles and plant displayed, examples of war-time economies effected by that department. Some of these examples illustrated the reclamation of old engine parts. The difficulties experienced in securing spare parts under war-time conditions had been realised before the actual outbreak of war and, in consequence, large quantities of worn material, which would normally have been scrapped, were set aside for reclamation. Such parts included crankshafts, the worn journals of which are built up to the original diameter by metal spraying or electro-deposition; camshafts, the cam profiles being built up anew by welding; starter rings, worn or broken teeth being also built up by welding, and the same process being employed in renewing the worn splines and journals of the gearbox shafts. The worn races of ball bearings are re-ground and oversize balls fitted. Piston skirts are expanded by a special process; the packing-ring grooves are trued-up and new rings and gudgeon pins fitted.

The steps which are normally taken to extend the life of the tyres of the various types of vehicles employed are supplemented by re-grooving the tread, where this is worn smooth and sufficient rubber remains, this operation being carried out by apparatus installed in the main road motor workshops. Such tyres as are too far worn for this treatment but are otherwise sound are re-moulded by the original makers or other specialist firms. Occasionally, however, a sound tyre may have its fabric damaged. Tyre manufacturers will not undertake such repairs and so special equipment to deal with major tyre repairs of this nature has been installed at one of the railway company's road motor depots to deal with this work and a staff has been trained for the purpose. The equipment includes a gas-fired boiler, a portable buffing machine with extended spindle for inner-tube work and repair units, with interchangeable fittings for various sizes of tyre. At this depot also work has been carried out in connection with the reclamation of used oil, a Bramley type oil cleaning plant having been installed there. Experience with this plant and collaboration with the railway company's research department has resulted in the recovery of 70 per cent. of the dirty oil treated. The reclaimed oil, totalling 14,000 gallons per annum, is being successfully used in engines and is stated to be equal in quality to fresh oil. An oil-cleaning plant of the type referred to was illustrated and described in ENGINEERING, vol. 145, page 528 (1938).

SPECTROGRAPHIC ANALYSIS OF SEGREGATES.

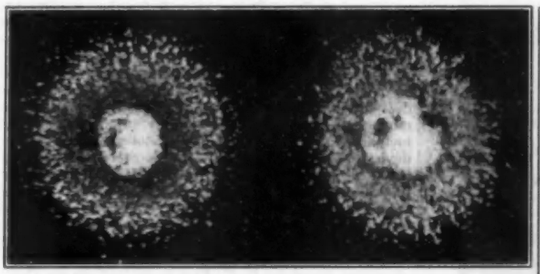


Fig. 1. Crater and Halo Obtained with Graphite Electrode; Oblique Illumination. × 8.

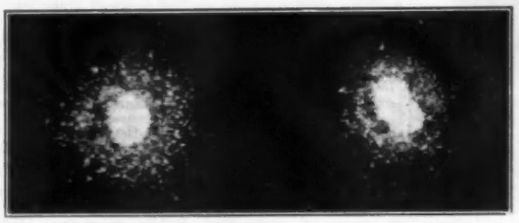


Fig. 2. As in Fig. 1, After Rubbing with Damp Polishing Cloth.

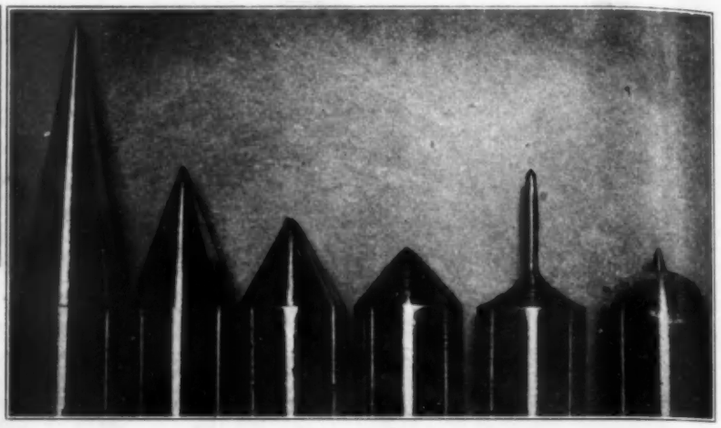


Fig. 3. Electrode Points to Obtain Reduced Sparking Area.

THE SPECTROGRAPHIC ANALYSIS OF SEGREGATES.*

By F. G. Barker, F.I.C., H. Convey, Ph.D., and J. H. Oldfield.

It was shown in a paper† entitled "Some Applications of the Spectrograph to the Analysis of Ferrous and Non-Ferrous Metals," which was read before a Joint Meeting of the Sheffield Metallurgical Association and the South Yorkshire Section of the Institute of Chemistry on February 7, 1939, that it was possible by means of the spectrograph to obtain at least a qualitative estimate of the composition of metallic segregates. At that time, however, no systematic study of the problem had been attempted, and the work done was chiefly to show the extent to which the presence of segregates might influence the results of routine spectrographic analysis rather than to determine their actual composition. The segregates examined were large, and the technique employed was the same as that used for the routine spectrographic analysis of steel. The matter aroused some interest, and the author was approached by the chairman of the Inclusions Sub-Committee to pursue the matter further, and work out, if found practicable, a technique for the quantitative analysis of segregates. This was undertaken. From the results of early experiments it soon became evident that, if the method was to be applicable to any but large segregates, the technique employed for routine analysis would have to be modified so as to reduce the area affected by sparking.

The method employed for routine analysis involves the use of a graphite rod with the end shaped to an 80-deg. cone, a 0·08-in. (2-mm.) spark gap, and six 10-second exposures on different parts of the sample superimposed upon one another to make a single spectrogram. The effect produced on a polished sample by sparking under these conditions is illustrated in Fig. 1, on this page. The light central part consists of a crater having a diameter of approximately 0·04 in., and a maximum depth of approximately 0·001 in. It is frequently of irregular shape, as shown in the right-hand illustration in Fig. 1, owing to preferential or irregular sparking. The left-hand illustration in Fig. 1 shows a normal crater and halo. In the immediate vicinity of the crater the surface has the appearance of being lightly etched, and around this there is a light-brown stain or deposit of oxide. The latter is readily removed by lightly rubbing on a damp polishing cloth, and the craters and halos then appear as shown in Fig. 2.

It was thought that a reduction in the area affected by sparking might be obtained by a change in the shape of the electrode point and by the use of a material which would keep its point better than graphite. Of the metals (excluding rare ones), which are available for use, and are not commonly present in steel, silver appeared to be one of the most suitable, and a series of tests was made with electrodes of this metal, shaped as shown in Fig. 3. Reading from left to right, the angle of cone of the first electrode is 20 deg., that of the second 40 deg., that of the third 60 deg., and that of the fourth 80 deg. The "wire point" of electrode No. 5 has a height of 0·25 in., and a diameter of 0·031 in., and the nipple point of electrode No. 6, on the extreme right, a height of 0·05 in. and an angle of cone of 36 deg.

Using the standard 0·08-in. (2-mm.) gap, only slight differences in the size of the crater and halo were obtained with the different electrodes. The wire-pointed one, No. 5, gave results inferior to those obtained with the one of graphite, the diameter of the crater and the corona being slightly greater. This was found to be due to irregular sparking caused by the spark climbing away from the tip of the electrode as its temperature increased during the period of sparking. This led to the development of the nipple-pointed electrode, No. 6. With this it was found that sparking was largely confined to the point, the heat developed there being dissipated in the body of the electrode more readily than with No. 5. The size of the crater formed with the nipple-shaped electrode was approximately the same as that obtained with one of graphite, but it had a more regular form because of the lesser tendency of the spark to wander.

Tests were next made to determine the extent to which the sparking area could be reduced by a reduction in the spark gap. The same electrodes were used, and tests were made with gaps of various amounts down to 0·002 in. With a decrease in gap there was a decrease in the sparking area, and the best results with respect to uniformity of crater, shape and halo were obtained with the nipple electrode, No. 6. All subsequent work was therefore done with electrodes of this type. With the smallest gap tested, viz., 0·002 in., and a 15-second exposure, the diameters of the crater and halo formed with this electrode were 0·008 in. (0·2 mm.) and 0·088 in. (2·2 mm.), respectively. An examination of spectrograms taken during the foregoing tests showed that, for given sparking periods, the line intensity diminished as the size of the gap was reduced, and that, with the 0·002 in. gap, lines of suitable intensity for the determination of the elements silicon, manganese, nickel, chromium, molybdenum and vanadium could be obtained with Ilford thin-film half-tone plates, which are used for routine analysis, only by making very long exposures or by superimposing many exposures upon one another—a course which would not be practicable except on large segregates. Further tests were therefore made, using the very much faster Kodak B10 Photoscript plate; this was found to possess great advantages over the other, and was used for all subsequent experiments.

A further reduction in sparking time was made possible by decreasing the distance between the arc and the slit of the spectrograph from 15·5 in., which is standard practice, to 4 in. It was also found that the sparking area could be further reduced if the electrode point were oxidised by sparking for 15 seconds before making the test; this, however, was not done in the position where a test was to be made. Spectrograms were prepared under these conditions, using a polished section of a 1-in. diameter bar of nickel-chromium-molybdenum steel on which macro-examination had not revealed segregation. With gaps up to 0·010 in., which gave the smallest sparking area, the spectrograms showed considerable variation in density. This was found to be due to slight variations in the position of the spark with respect to the optical axis of the spectrograph. The problem of alignment presented considerable difficulty, and it was ultimately found that a spark gap slightly greater than that which gave the smallest crater had to be accepted. From further experiments it was found that results which were satisfactory as regards reproducibility and sparking area were obtained with a gap of 0·015 in., and a single exposure of 15 seconds. As a result of these tests, the following conditions were provisionally adopted for the analysis of segregates:—

Wave band	2,200 to 3,000 Å.
Slit width	0·0006 in.
Distance of electrode from slit	4 in.
Spark gap	0·015 in.
Voltage	15,000.
Upper electrode	Silver rod, nipple-pointed and oxidised by pre-sparking for 15 seconds.
Plate	Kodak Photoscript B10.
Exposure time	15 seconds.

The effect on a polished specimen of sparking under the above conditions is illustrated in Fig. 4, opposite, and Fig. 5 shows the same specimen after lightly rubbing on a wet polishing cloth. The diameter of the crater is approximately 0·012 in. and that of the halo approximately 0·10 in. The depth of the crater, as measured with a Société Genevoise measuring instrument, Type MU-214B, on which an accuracy of ±0·00005 in. is claimed, is 0·0007 in. The weight of steel corresponding to the volume of the crater is approximately 0·000005 g.

Standard curves, relating the log. ratio of the line intensity to the percentage of element present, which were prepared from chemically standardised steels, are shown in Figs. 9 to 13, opposite. The graph for the determination of silicon from spark spectrograms is shown in Fig. 9; that for the determination of manganese in Fig. 10; that for nickel in Fig. 11; that for chromium in Fig. 12; and that for molybdenum in Fig. 13. Each point on the curves is the average of ten spectrographic determinations.

Before commencing the examination of segregates it was necessary to establish whether the results of tests were dependent entirely on the spectral emission resulting from the main central discharge which forms the crater, or whether they were influenced by emission from the zone around the crater which has the appearance of a halo. The following tests were therefore made: A ¼-in. hole was drilled and ground in the centre of a piece of mild steel, 1¼ in. square by 1 in. thick, which

* Contribution from the Admiralty Inspection Department, Sheffield, entitled "The Application of Spectrographic Methods to the Analysis of Segregates," submitted by the Inclusions Sub-committee of the Committee on the Heterogeneity of Steel Ingots to the Iron and Steel Institute for written discussion. Abridged.

† See Engineering, vol. 147, pages 572 and 605, (1939).

SPECTROGRAPHIC ANALYSIS OF SEGREGATES.

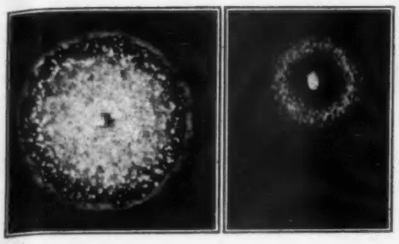


FIG. 4.

FIG. 5.

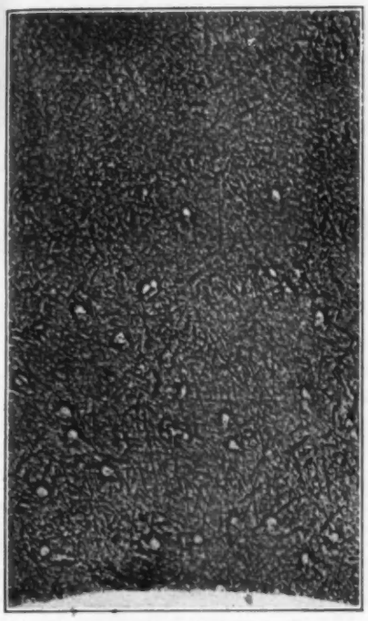


FIG. 6. TRANSVERSE SECTION OF PORTION OF NI-CR-MO FORGING. × ⅔.

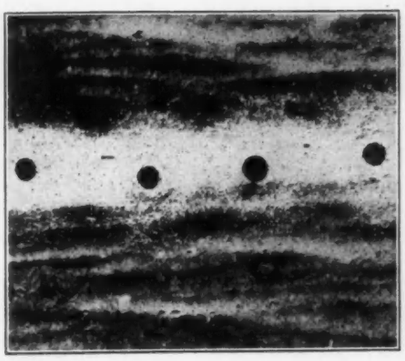


FIG. 7. LONGITUDINAL SECTION OF NI-CR-MO FORGING. × 10.

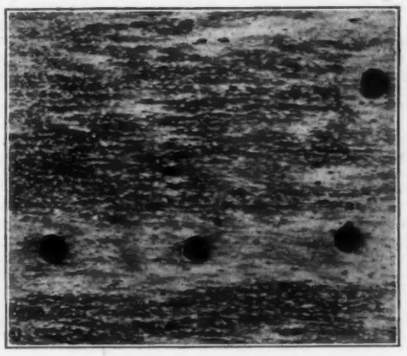
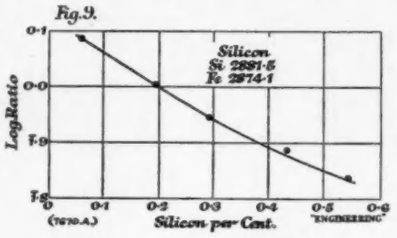
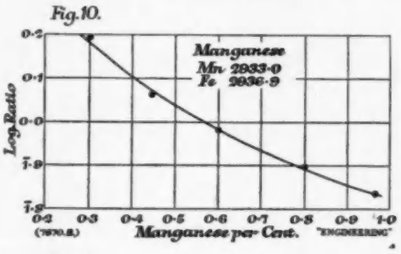
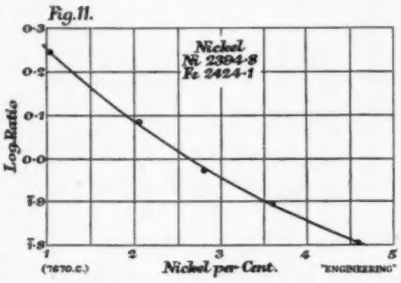
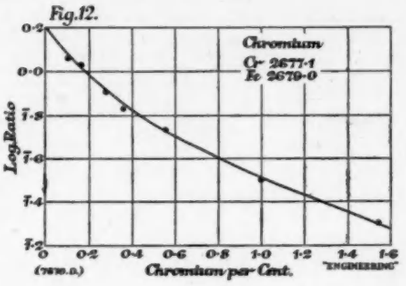


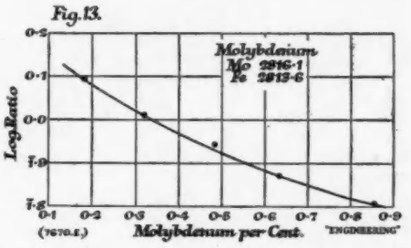
FIG. 8. LONGITUDINAL SECTION OF NI-VA FORGING. × 10.











did not contain more than traces of nickel, chromium and molybdenum. A piece of nickel-chromium-molybdenum steel was ground slightly taper to make a tight fit in the mild-steel block, and was forced in under a hydraulic ram. The face was ground, polished and very lightly etched. A number of spectrograms were then prepared by sparking on the mild steel in such positions that the resulting halo overlapped the alloy steel by various amounts. An examination of the spectrograms showed that not more than faint traces of the alloy elements appeared until the edge of the crater was at the actual junction of the two metals, thus establishing that emission from the halo does not influence the results of tests.

An examination of a number of segregates occurring in large forgings of nickel-chromium-molybdenum and nickel-vanadium steels was next undertaken. Specimens of the former were obtained from a large hollow cylindrical forging, an etched section of which is shown in Fig. 6, on this page. Most of the segregates were roughly circular in cross-section, having a diameter of approximately 0·04 in. to 0·08 in. Their length, however, was considerably greater, and on this account longitudinal sections were prepared for spectrographic examination. As the segregates were not visible on polished sections, an etch was necessary to locate them. Of the various etching reagents in common use, previous experience had indicated that Oberhoffer's reagent was one of the most suitable, because the macrostructure and the segregates were readily revealed with the minimum of attack on the specimen. After etching, a number of separate exposures were made on the segregate and on the normal metal in positions well removed from it. The macrostructure of the specimen, and the size of the craters formed during the exposure, relative to the width of the segregate, are shown in Fig. 7, on this page. The results of analysis are given in Table I.

Another specimen cut from a forging of similar composition which contained segregates of a similar type was also examined, with the results given in Table II, on page 300. The results on the non-segregated parts show greater variation than that generally obtained under normal conditions of routine analysis. Such variation, however, is not surprising, having in view the smallness of the area affected by sparking and the coarseness of the macrostructure. Much greater variation is shown in the results obtained from the segregates. The greatest differences occur on the manganese and molybdenum contents, the former being accounted for by the large inclusions of manganese sulphide, which were found to be much more numerous in the segregates than in the normal metal. An examination of the average compositions of the normal metal and the average of the segregates shows higher values for the latter for all elements; the greatest increases, however, occur with manganese and molybdenum, particularly the latter, where it amounts to 50 per cent. and 45 per cent., respectively, on the two forgings.

An example of segregates found in a nickel-vanadium steel forging is shown in Fig. 8, above. Average results of five tests made in a similar manner to those described above are given in Table III, page 300. Here again, higher average values for all elements were obtained on the segregates, and the greatest increases are shown for manganese, molybdenum and vanadium. The problem of assessing the accuracy of these results is made very difficult because it is not possible when testing a heterogeneous material such as steel, under conditions such as those described above, to determine to what extent variability in the results is due to actual variation in composition and to what extent it is due

TABLE I.—*Results of Tests on Nickel-Chromium-Molybdenum Steel A.*

Test No.	Si Per cent.	Mn Per cent.	Ni Per cent.	Cr Per cent.	Mo Per cent.
Tests on Non-Segregate.					
1	0·15	0·49	2·77	0·65	0·43
2	0·17	0·46	2·68	0·59	0·42
3	0·18	0·50	2·68	0·59	0·44
4	0·17	0·46	2·55	0·55	0·39
5	0·17	0·47	2·75	0·62	0·44
6	0·18	0·46	2·68	0·59	0·43
7	0·17	0·45	2·60	0·56	0·38
8	0·16	0·49	2·65	0·56	0·39
9	0·17	0·47	2·73	0·61	0·42
10	0·17	0·46	2·68	0·58	0·40
Average	0·17	0·47	2·68	0·59	0·41
Greatest deviation from average	+0·01 / −0·02	+0·03 / −0·02	+0·09 / −0·13	+0·06 / −0·04	+0·03 / −0·03
Tests on Segregate.					
11	0·20	0·47	3·02	0·71	0·88
12	0·21	—	3·07	0·73	0·78
13	0·21	0·66	2·94	0·72	0·63
14	0·21	0·73	2·90	0·68	0·66
15	0·21	0·49	2·78	0·61	0·52
16	0·19	0·53	2·82	0·65	0·53
17	0·19	0·49	2·87	0·62	0·51
18	0·21	0·53	3·00	0·72	0·54
19	0·19	0·50	2·76	0·64	0·55
20	0·21	0·54	3·01	0·75	0·57
Average	0·20	0·55	2·92	0·68	0·62
Greatest deviation from average	+0·01 / −0·01	+0·18 / −0·08	+0·15 / −0·16	+0·07 / −0·07	+0·26 / −0·11

to experimental error in the technique employed. It has been shown that the weight of metal actually involved in making an analysis is approximately 0·000005g., and, even though it were possible to isolate such an amount for chemical examination, it is quite beyond the scope of the most modern methods of micro-analysis to obtain quantitative results from such a quantity.

It appeared that the best that could be done with the materials available was to obtain further evidence of reproducibility on bars of small section in which heterogeneity was less evident than in large forgings. Cross-sections of 1⅛-in. and 1-in. diameter bars were therefore prepared by polishing and etching, and ten tests made on each. These results were considered to indicate reproducibility of a satisfactory order, and tended to confirm that the very much wider differences experienced with forgings, between the results on normal metal and those on segregates, were due largely to differences in actual composition. A number of the spectrograms obtained in the course of the tests reported above have been examined for carbon, but the

TABLE II.—*Results of Tests on Nickel-Chromium-Molybdenum Steel B.*

Test No.	Si Per cent.	Mn Per cent.	Ni Per cent.	Cr Per cent.	Mo Per cent.
Tests on Non-Segregate.					
1	—	0·44	2·58	0·67	0·42
2	0·16	0·45	2·62	0·65	0·39
3	0·17	0·50	2·55	0·59	0·40
4	0·17	0·49	2·63	0·66	0·44
5	0·18	0·47	2·65	0·63	0·47
6	0·19	0·49	2·62	0·60	0·44
7	0·17	0·47	2·61	0·60	0·39
8	0·16	0·44	2·55	0·59	0·39
9	0·16	0·49	2·61	0·58	0·38
10	0·16	0·48	2·70	0·66	0·44
Average	0·17	0·47	2·61	0·62	0·42
Greatest deviation from average	+0·02 / −0·01	+0·03 / −0·03	+0·09 / −0·06	+0·05 / −0·04	+0·05 / −0·04
Tests on Segregate.					
11	0·20	0·49	2·92	0·68	0·63
12	0·21	0·51	2·63	0·59	0·51
13	0·19	0·49	2·80	0·62	0·51
14	0·20	0·52	2·83	0·66	0·66
15	0·21	0·94	2·91	0·62	0·60
16	0·20	0·76	2·95	0·64	0·56
17	0·22	0·68	3·12	0·78	0·74
18	0·20	0·77	2·91	0·67	0·65
19	0·20	0·74	2·63	0·57	0·48
20	0·20	0·60	3·06	0·74	0·68
Average	0·20	0·65	2·86	0·66	0·60
Greatest deviation from average	+0·01 / −0·01	+0·29 / −0·16	+0·26 / −0·23	+0·12 / −0·09	+0·14 / −0·09

TABLE III.—*Results of Tests on Nickel-Vanadium Steel Forging.*

—	Si Per cent.	Mn Per cent.	Ni Per cent.	Cr Per cent.	Mo Per cent.	Va Per cent.
Tests on Non-Segregate.						
Average (5 tests)	0·25	0·68	2·54	0·14	0·12*	0·09
Greatest deviation from average	+0·04 / −0·02	+0·08 / −0·06	+0·09 / −0·07	+0·01 / −0·01	+0·07* / −0·02*	+0·05 / −0·03
Tests on Segregate.						
Average (5 tests)	0·26	0·80	2·74	0·15	0·17	0·18
Greatest deviation from average	+0·02 / −0·02	+0·05 / −0·07	+0·06 / −0·07	+0·02 / −0·02	+0·03 / −0·04	+0·03 / −0·02

* Approximately.

results, even on the small bars, showed such variation as to make it doubtful whether the conditions of test employed are satisfactory for this element. No results have therefore been reported, and further work to determine the best conditions for the estimation of carbon is in hand.

It should be pointed out that, when making the tests on segregates, the actual points tested did not in many instances fall on the axis of the segregates, and their positions relative to the axis were generally irregular. It is considered that the variation in composition which is indicated to exist within a single segregate is probably due to this cause, and an effort is now to be made to determine the graduation in composition from one side to the other. It is proposed to carry out tests under conditions in which the photographic plate and the specimen are slowly traversed during sparking, their movements being synchronised, so that a continuous spectrogram showing the graduation in composition across the segregate may be obtained. Much work, however, will have to be done to establish the best conditions for such a test, and this will form the subject of a future paper.

"ENGINEERING" ILLUSTRATED PATENT RECORD.

ABSTRACTS OF SPECIFICATIONS RECENTLY PUBLISHED UNDER THE ACTS OF 1907 TO 1939.

The number of views given in the Specification Drawings is stated in each case; where none is mentioned, the Specification is not illustrated.

Where inventions are communicated from abroad, the Names, etc., of the Communicators are given in italics.

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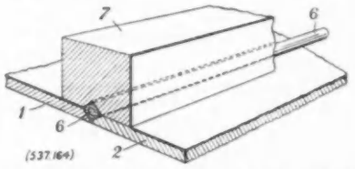
Any person may, at any time within two months from the date of the advertisement of the acceptance of a Complete Specification, give notice at the Patent Office of opposition to the grant of a Patent on any of the grounds mentioned in the Acts.

ELECTRICAL APPARTUS.

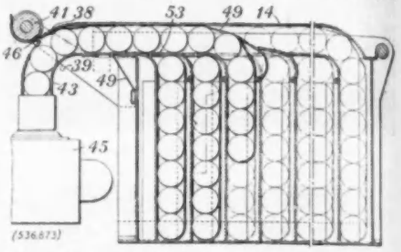
537,164. Electric Arc-Welding Process. G. D. Peters and Company, Limited, of Slough, and R. Needham, of Slough. (11 *Figs.*) April 17, 1940.—The invention is a method of effecting long welds by electric arc, the welding being performed automatically and the need for highly skilled labour being eliminated. The edges of the plates 1 and 2 to be butt-welded are machined to form a weld-metal channel. The welding electrode 6 is laid in the channel and a heavy-section backing bar 7 is applied. The backing bar has, in the face which lies snugly against the plates 1,2, an inverted V-shaped recess which accommodates the portion of the electrode standing proud of the plates. The shape of this recess leaves a gas passage between the electrode and the backing bar and also at the sides of the electrode. At one end, the backing bar 7 has an insulated connector for the positive lead of the arc circuit to the end of the electrode 6. The other end of the electrode projects slightly beyond the end of the backing bar to enable the arc to be struck



by a carbon pencil which is carried in a holder pivoted on the end of the backing bar so that it can be swung into and out of the arc-striking position. When the current is switched on and the arc struck, the carbon pencil is removed from the region of the arc, and the welding which has commenced will continue automatically until the portion of the electrode enclosed by the backing bar and work is consumed. Gas generated in the region of the arc as the welding proceeds will fill the space enclosed by the parts being joined and the backing bar, thereby excluding air from the region of the arc. The weld produced is regular and has a relatively smooth surface and the exclusion of oxygen from the region of the arc ensures an efficient weld. The length of the welds is limited only by the length of the solid coated electrodes. It has been found practicable to make the electrodes up to 30 ft. in length, and as the welding proceeds at the rate of approximately 1 ft. per minute there may be a relatively long interval between the commencement and finishing of a weld during which the operator may perform other useful work, as it is unnecessary for him to stand by the machine once the weld has been started. (*Accepted June* 11, 1941.)

GUNS AND EXPLOSIVES.

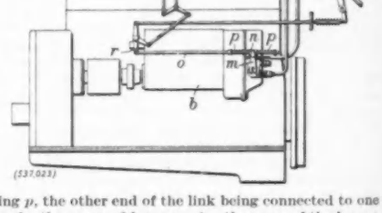
536,873. Aircraft-Cannon Magazine. The Bristol Aeroplane Company, Limited, of Bristol, and W. G. Morgan, of Bristol. (3 *Figs.*) September 28, 1939.—The magazine is designed especially for small-calibre quick-firing aircraft cannon. The magazine and feeding device are of light weight, certain in operation and simple to load. The interior magazine is subdivided by vertical partitions into separate compartments from front to back, and the lid 14 is curved at each end to form a guide for the rounds. The front of the magazine carries two brackets 39, which support a spindle carrying a roller 41. The brackets 39 also support an arcuate chute 43, which is connected at its lower end to the breech of the cannon 45. The upper end of the chute is cut away at the top, which is closed except for a slot 46 by the curved portion 38 of the lid. The front wall of the magazine also carries an anchorage for a canvas band 49 nearly as wide as the magazine. From the anchorage, the band 49 passes round a curved forward extension of the top of the front partition. From this point the band passes down the inside of this partition to form a bight in the front compartment. A flap 53, which is hinged to the rear partition normally closes the top of the compartment. The canvas band passes under the lip of this flap and forms another bight in the next compartment, and so on until each compartment contains a bight of the canvas band, as shown in chain lines, when the magazine is full. Each bight contains a vertical column of rounds. A horizontal compartment extends below the lid along the tops of all the vertical compartments, and the band from the last bight runs along the curved rear end of the lid to form, in effect, a horizontal bight containing a horizontal row of rounds. The band leads through the slot 46 round the roller 41, and is fastened to a spring-drum which is driven either by a



hydraulic motor or by the recoil of the gun. Thus, the band forces rounds one behind the other along the horizontal compartment into the chute 43 and so into the breech. The magazine is filled by opening the lid 14, lifting the flap 53, passing seven rounds into the front compartment so that they are held in the bight of the band, closing the flap 53, passing the band into the next compartment, filling it with seven more rounds and so on until the rear compartment has been filled. The rounds are then stacked along the tops of the flaps 53. The magazine can be used in any position, regardless of the action of gravity. (*Accepted May* 30, 1941.)

INTERNAL-COMBUSTION ENGINES.

537,023. Gas or Oil Engine. C.A.V. Limited, of London, and W. E. W. Nicolls, of London. (3 *Figs.*) December 4, 1939.—The engine operates either with oil injected by a pump, or with a gas and air mixture ignited by small quantities of oil which are injected into the cylinders by the pump and are ignited by the heat of compression. The injection pump *b* is controlled by the usual centrifugal governor, the controlling lever being pivoted on a manually adjustable eccentric. On the eccentric spindle are secured a pair of abutments which contact respectively with a pair of stops each loaded by a strong spring. The one stop determines the eccentric setting for the pump to supply the engine with enough oil for idling speed while the other stop determines the eccentric setting for the pump to supply the quantity of oil required for ignition of the gas-air mixture. To the eccentric spindle is clamped a lever *m* the other end of which is pivoted on a block *n* through which slides an operating link *o*. At each side of the block on the link is a



spring *p*, the other end of the link being connected to one arm of a three-armed lever *r*. Another arm of the lever *r* is connected through another link to a pedal and the third arm is connected to the throttle valve. When the throttle is closed, no gas is admitted and the engine is kept idling by oil supplied by the injection pump. On depressing the pedal, the throttle is opened to admit gas to the engine. At the same time the lever *m* is moved away from the stop which determines the "idling" supply of oil, and up to the other stop for "ignition" injection. The springs *p* on the link, being considerably weaker than the springs which load the stops, take up further movements of the pedal. To enable the engine to be run normally on oil fuel only, the ignition injection stop is manually retractable through a Bowden cable *x*, so that it allows sufficient further movement of the eccentric to enable the pump to operate normally. The cable *x* is also connected to the operating lever of a valve which controls the flow of gas to the induction manifold, the lever being operated by the driver and the arrangement being such that closure of the valve is accompanied by retraction of the stop. (*Accepted June* 5, 1941.)